Application for a Performance-Based, Multi-Site Radioactive Materials License to Operate a High-Pressure Slurry Ablation Remediation System

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U.S. Nuclear Regulatory Commission

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prepared for:

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SECTION 1.0 INTRODUCTION

Disa Technologies, Inc. (Disa) is seeking a Performance-Based, Multi-Site Radioactive Materials License (RML) from the U.S. Nuclear Regulatory Commission (NRC) for Disa's High-Pressure Slurry Ablation (HPSA) waste remediation technology. This technology uses mechanical and kinetic energy to liberate and separate mineral-rich patinas, containing constituents of concern (including uranium and/or thorium), from host sand grains. Disa is seeking to license the HPSA technology for use in site reclamation/remediation to significantly reduce the volume and radiological and toxicity characteristics of waste rock from abandoned uranium mines and other contaminated sites. Disa prepared this license application using NUREG-1556, Volume 12, which appeared to contain guidance that most closely resembled the type of license that Disa is seeking (NRC, 2018a).

Waste reduction occurs by creating isolated mineral fraction and a clean coarse fraction that is an inert product of the remediated material. The isolated mineral fraction includes vanadium, source material, and other constituents of concern (e.g., RCRA metals). The isolated mineral fraction, which makes up approximately 15% of the volume of the remediated contaminated material, is transported offsite as alternate feed at a uranium recovery facility or for disposal at a licensed low-level radioactive waste facility. The clean coarse fraction can be left in place or used for other purposes onsite, such as filling or grading.

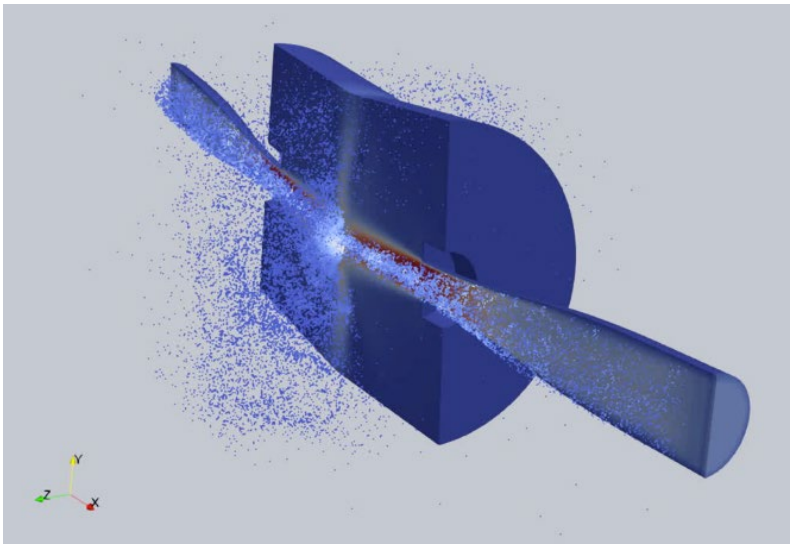
Disa understands that this technology by virtue of its efficiency in extracting contaminated mineral material could potentially have value in uranium recovery in addition to reclamation/remediation. However, Disa only seeks a reclamation/remediation license that would be regulated under 10 CFR Parts 20 and 40. Other uses of the HPSA technology are not contemplated here. Any other use of the HPSA technology may require a uranium recovery facility license under 10 CFR Part 40, Appendix A, or incorporation into another company's milling license.

1.1 Technology Description

HPSA is a patented technology owned by Disa. To use the HPSA technology, waste rock is crushed and slurried. Disa will utilize dust suppression methods (e.g., water spraying or dust enclosure), as part of the crushing process. After creating the slurry, it is pumped through injection nozzles that are contained in a steel enclosure. Use of high-pressure nozzles creates a high energy impact zone that separates the mineral-rich patina from the host sand. No chemicals are used in the mineral extraction process. This HPSA process will generally be used on roll front uranium deposits or similar deposits or contaminated soils where the mineral-rich material exhibits association with the host rock.

The principal HPSA action is the focused high energy collision of particles inside the high energy impact zone enclosed within the HPSA collision chamber. These collisions result in liberation and disassociation of composite materials. Softer minerals and contaminants are fractured into smaller particles while harder, host materials remain intact, increasing surface areas and improving separation rates. A computational model of the collision zone is shown in Figure 1-1.

Figure 1-1: Collision Zone Model



Source: cmpip, 2022

The HPSA process is uniquely effective in remediating composite materials that can be fractured along discreet subfraction boundaries. The high energy collision zone depicted in Figure 1-1 allows a thin, soft, mineral-rich patina coating of a material such as those found on sand grains in roll front, sandstone hosted uranium deposits to be easily ablated as a result of the low and mid-shear stresses inside the collision chamber. Low and mid-shear stresses cause distortion, deformation, and rebounding, allowing for sand grain particles to remain intact while the thin patina coating of uranium is fractured into the isolated mineral fraction.

The HPSA system includes three main components. Component one is the waste rock loading and slurry transfer system. Component two is the pump nozzle assembly, including the collision chamber and the pumps that discharge through the nozzles. Component three is the solids separation and dewatering process. This part of the system is dependent on the application. Figure 1-2 shows and example of a HPSA unit.

Figure 1-2: Large Scale HPSA Unit

Source: cmpip, 2022

1.2 Technology Use

Disa's HPSA is a revolutionary remediation technology focused on improving the financial viability of abandoned uranium mine site cleanup. Beyond waste rock piles, HPSA has applications in petroleum contamination remediation, iron ore tailings processing, and other tailings processing applications. For example, in one study, results from diesel range organics (DRO) and gasoline range organics (GRO) analysis concluded that the HPSA process reduces the total extractable hydrocarbons (TEH) by 80% in most circumstances. For iron mine tailings, HPSA proved to be highly effective at reducing average particle sizes (comminution) in addition to mineral liberation.

Disa seeks to apply its HPSA technology to remediate waste rock piles and contaminated soils associated with abandoned uranium mines and other contaminated sites that contain radioactive constituents and other constituents of concern (e.g., vanadium, RCRA metals). The fate of the isolated mineral fraction will depend solely on the customer; some customers will require disposal, while others may prefer the isolated mineral fraction to be treated as alternate feed. Disa, using its HPSA technology, seeks to remove the radioactive materials and toxicity hazards posed by abandoned or decommissioning contaminated sites, transport the source material in the isolated mineral fraction offsite to minimize waste, and leave a clean coarse fraction (inert material) that can be left in place or used for site reclamation.

For the purposes of this application, the term inert is defined as follows:

> Inert material means non-water soluble and non-putrescible solids together with such minor amounts and types of other materials, unless such materials are acid or toxic producing, as will not significantly affect the inert nature of such solids. The term includes, but is not limited to, earth, sand, gravel, rock, concrete which has been in a hardened state for at least sixty days, masonry, asphalt paving fragments, and other inert solids.

Data presented in this application demonstrates that the clean coarse fraction meets the definition of inert.

1.3 Licensing Precedence

The license sought by Disa is similar to the license issued by the NRC staff to R.M.D. Operations, LLC (a.k.a. Water Remediation Technology, LLC (WRT), License No. SUC-1591. WRT requested and was granted a performance-based, multi-site license for establishing its ion exchange systems at water treatment plants. However, WRT also established its ion exchange systems at inactive mine sites undergoing reclamation (i.e., Schwartzwalder Mine, Golden, Colorado). WRT's clients own sites that were previously unlicensed and not subjected to the NRC's environmental review process. However, WRT's main goals are treating drinking water and treating contaminated mine water.

Disa's activities are completely analogous to WRT's; Disa will perform remediation at abandoned or inactive uranium mine sites and other contaminated properties. In the same manner as WRT, source material that is isolated will be transported offsite for disposal or use as an alternate feed. The one major difference is that Disa's operations are short-term, while WRT's are long-term. However, in both cases, sites and/or equipment will be decontaminated and decommissioned with no environmental harm.

The NRC staff has raised concerns regarding the lack of environmental reviews for abandoned uranium mine sites. The staff addressed this issue in the WRT license by adding the following license conditions regarding endangered species and cultural resources:

> 11. R.M.D. Operations, LLC will consult with State and/or local historic preservation officers or similar governing body before beginning construction related to, or the use of, a uranium removal system that is located outside of, or away from, existing community water system structures.
>
> 13. R.M.D. Operations, LLC will consult with Federal or State fish and wildlife agencies to identify potential endangered or threatened species before beginning construction related to, or the use of, a uranium removal system that is located outside of, or away from, existing community water system structures.

Disa will agree to these same license conditions regarding endangered species and cultural resources.

1.4 Phased Licensing Approach

While similar licenses have been issued by NRC staff in the past, Disa understands that the license it is seeking may be considered novel, and an approval of the entire performance-based, multi-site license may require an extended timeline and resources. To assist the agency with a more expeditious review and approval process, Disa will agree to a license condition that temporarily limits NRC staff approval to one

HPSA unit. During this phased approval, Disa will use its HPSA technology to treat a minimum of 7,500 tons of waste rock over a maximum of 90 days , during which the NRC staff will be invited to witness this first project.

During this initial project, Disa will collect samples for analysis to demonstrate that the technology produces a clean coarse fraction, and renders a site safer than before the project. Disa's Safety and Environmental Review Panel (SERP) will review the analytical data collected during this project and provide its assessment regarding the safety of the HPSA process. Disa will submit this SERP report for review to the NRC staff. Provided that the SERP has confirmed the safety of the HPSA process, once Disa submits this SERP report, Disa will be entitled to utilize the full licensing authorization sought in this application. A proposed license condition is provided in Section 8.0.

1.5 Application Organization

The remaining portion of this application is organized to supplement the Radioactive Materials License Application Form (NRC Form 313) that is included at the beginning of this document. Proceeding sections include:

- Section 2.0 – Authorized Users (Form Item No. 7)
- Section 3.0 – Radioactive Materials (Form Item No. 5)
- Section 4.0 – Licensed Activities (Form Item Nos. 6 and 9)
- Section 5.0 – Radiation Protection Program (Form Item No. 10, 11)
- Section 6.0 – Dose Assessment (Form Item No. 10)
- Section 7.0 – Financial Assurance

Where information directly relates to items in the aforementioned application form, those item numbers are added to section headings to help guide the reader.

SECTION 2.0 AUTHORIZED USERS (FORM ITEM 7)

2.1 Radiation Safety Officer and Alternate Radiation Safety Officer

Andrew Halverson, Disa, will serve as the Radiation Safety Officer (RSO) for this license. Appendix A contains the qualifications for the RSO and the qualifications of Mr. Halverson. Section 6.0 discusses the training program to be developed under this license. Appendix B contains a sample radiation safety training class. Disa will, in the future appoint an Alternate Radiation Safety Officer (ARSO) and will amend the license to include this person.

2.2 Radiation Safety Technician

The Radiation Safety Technician(s) (RSTs) will be approved by the Radiation Safety Officer based on qualifications and experience. Appendix A contains the RST qualifications.

2.3 Authorized Users

Authorized users for Disa include the following:

- Greyson Buckingham, CEO, Disa
- John Lee, COO, Disa
- Madeline Orrell, Disa
- Field Services Manager
- Site Operators

The Field Services Manager and various site operators will be appointed prior to mobilizing to each site. All training will be completed and documented prior to any authorized user participating in site operations.

SECTION 3.0 RADIOACTIVE MATERIALS (FORM ITEM 5)

3.1 Radioactive Materials from HPSA Operations

Disa proposes a non-possession license to utilize its HPSA for reclamation/remediation work at uranium mine waste piles and other contaminated properties. Table 3-1 contains information regarding the materials requested for use in this license application. Disa will not take ownership of any radioactive materials encountered at clients' sites. However, Disa will be handling and packaging radioactive materials to support its reclamation and remediation efforts.

Table 3-1: Requested Materials for Licensure

Radionuclide(s)	Form	Container or Type	Maximum Concentration or Quantity	Maximum Activity per Source/Sample	Total Activity
Source material	Slurry Paste	Drums or lined roll off containers	Unlimited Quantity	NA	NA
Th-230	Electroplated Disk	N/A	NA	0.675 µCi (25,000 dpm)	6.75 µCi (250,000 dpm)

Disa is requesting an unlimited quantity of source material. Because Disa will be remediating multiple sites at one time and continually through the warm months, Disa cannot provide a precise quantity of source material that will be handled at any given time. An unlimited quantity is commonly used for remediation licenses or licenses where specific quantities cannot be estimated (see WRT (RMD) License No. SUC-1591). Furthermore, Disa is seeking to license 10 thorium-230 (Th-230) sources for function-checking instruments.

Disa will be generating source material (isolated mineral fraction) as a result of the HPSA operations for the sole purpose of site reclamation/remediation by reducing the radioactivity in waste rock to allow for a safer site reclamation. Disa will store the isolated mineral fraction in a secure container that will eventually be transported offsite. If the isolated mineral fraction is to be transported to a low-level radioactive waste disposal facility, arrangements will be made to obtain the necessary permits from the applicable low-level waste compacts (importing and exporting compacts).

Disa anticipates treating waste rock with a maximum concentration of 1,500 mg/kg source material (uranium and/or thorium); however, some waste rock materials may contain more source material. For the purposes of this license, Disa expects that the maximum uranium and/or thorium concentration in the isolated mineral fraction will be 7,000 mg/kg. Disa derived this maximum concentration by back calculating the maximum concentration it would allow to remain in the clean coarse fraction (< 500 mg/kg). Under no circumstance will the uranium concentration in the clean coarse fraction be equal to or exceed 500 mg/kg.

3.2 Calibration and Reference Sources

To ensure radiation detection instruments and equipment used are functioning and within acceptable operating ranges, Disa will maintain an inventory of calibration and reference (check) sources. Alpha, beta, and gamma sources will be necessary for the range of instruments to be used. The sources will be owned or rented, and Table 3-2 describes these sources.

Table 3-3: Calibration and Reference Sources

Source	Radionuclide(s)	Form	Maximum Activity per Source	Maximum Number of Sources
Beta	Tc-99	Electroplated Disk	30,000 dpm	10
Gamma	Cs-137	Button, Disk	10 µCi (370 kBq)	10

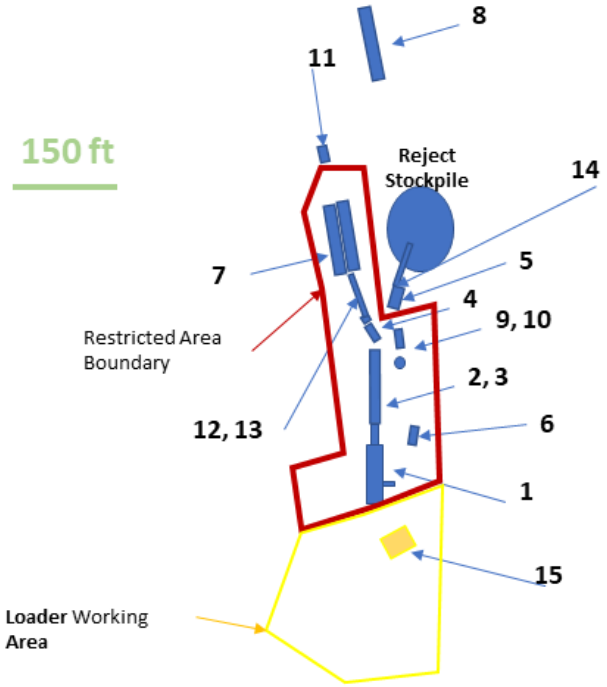
SECTION 4.0 LICENSED ACTIVITIES (FORM ITEMS 6 AND 9)

4.1 Description of Remediation

Disa's operations include the transportation and assembly of its HPSA units at various temporary sites to be used for reclamation/remediation. Disa shall notify the NRC staff at least 14 days prior to work commencing on any project site. A typical layout is found in Figure 4-1.

Figure 4-1: Typical Layout (Form Item 9)

Feature Number	Equipment Description	Approximate Size [L x W x H]
1	Crusher and 0.25" Screen	56'6" x 19'1" x 15'5"
2	HPSA Processing Unit	30' x 9' x 11'
3	HPSA Unit Containment Berm	50' x 10' x 1'6"
4	Product Centrifuge/Filter Press	16' x 9' x 10'
5	Clean Coarse Centrifuge/Filter Press	16' x 9' x 10'
6	Analytical Trailer	24' x 8'6" x 8'6"
7	Loaded Transportation Truck	(24' x 8' x 5.6') x 2
8	Unloaded Transportation Truck	24' x 8' x 5.6'
9	Process Water Tank	24' x 12' x 13'
10	Process Water Treatment Unit	11' x 8' x 8'
11	Office Trailer/Lavatory	30' x 9' x 10'
12	Product Centrifuge/Filter Press Hopper	8'x 5' x 4'
13	Product Centrifuge/Filter Press Auger Conveyor	20' x 6' x 8"
14	Clean Coarse Centrifuge/Filter Press Stacker	35' x 2' x 16"
15	Front-end Loader	15' x 9' x 11'4"



As shown in Figure 4-1, Disa will establish a restricted area to include all aspects of the operation that will handle and manage source material. Equipment and operations that are not used to handle or manage source material will be excluded from the restricted area including: the clean coarse fraction stockpile, clean coarse fraction centrifuge (5), empty transportation trucks (8), office trailer/lavatory (11), and clean coarse fraction centrifuge stacker (14). Although Figure 4-1 represents a typical layout, other equipment may be brought onto a particular site or substituted, as needed. Substitute equipment may be larger or smaller depending upon the HPSA unit capacity. No equipment will require the use of chemicals; HPSA is completely mechanical. If additional equipment will be used to handle and/or manage source material, it will be located in the restricted area. Regarding other equipment required by the application, the locations are as follows:

- Safety equipment will be stored in the Analytical Trailer (Feature No. 6).

- Safety equipment and features related to spill response and containment include a containment berm (Feature No. 3) and shovels and drums for removing and storing potentially contaminated soils. (Form Item 9)
- Radioactive material warning signs will be placed at each access/egress point and on each side of the restricted area.
- Notice to Employees and emergency telephone numbers will be maintained in the Office Trailer (Feature No. 11).

Once the HPSA system is set up on a site, waste rock will be crushed to size it appropriately for the HPSA. Water or dust enclosures will be used in the crushing process for dust suppression and to slurry the crushed waste rock. Once slurried, the mixture is transferred to the hopper on the HPSA to feed the collision chamber. After collision, the resulting stream is mechanically separated to isolate the clean coarse fraction (reject, > No. 270 sieve) and isolated mineral fraction (< No. 270 sieve).

The isolated mineral fraction will be containerized in a lined dumpster, or other suitable container, and covered to protect it from the elements, except during loading operations. The clean coarse fraction will be placed in a pile and will remain onsite. Once the operation is completed, the isolated mineral fraction will be transported offsite for utilization as an alternate feed at a licensed uranium recovery facility, or another facility that is licensed to utilize or dispose of the isolated mineral fraction. Disa will notify the NRC staff by email, which facility will receive the isolated mineral fraction. All transportation and facility receipt documentation will be maintained by Disa at its Casper, Wyoming, headquarters pursuant to NRC regulations.

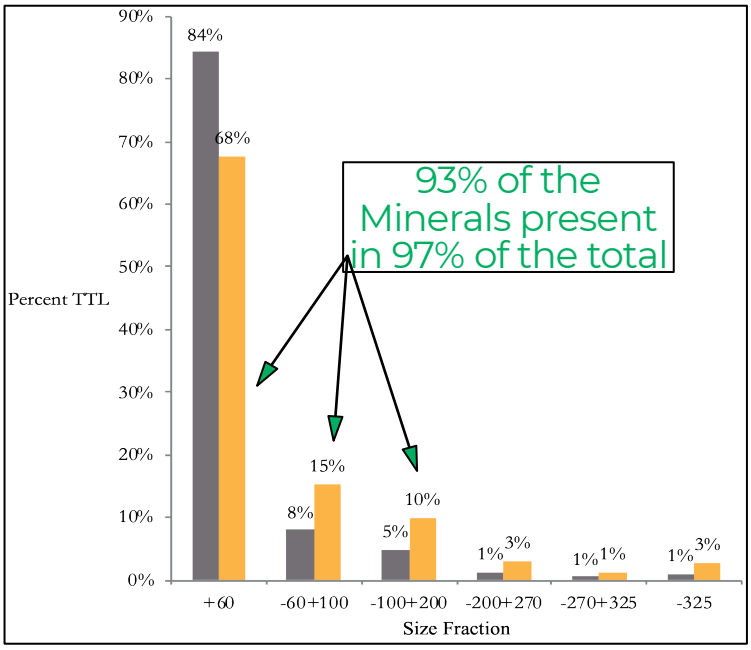
Water is needed for the HPSA process to slurry the crushed waste rock and for to transport particles to the collision chamber in the HPSA unit. Disa will require at least 2,000 gallons of water to start the process and makeup water will be require due to water loss; water loss is primarily in the form of moisture that is contained within the isolated mineral fraction and the clean coarse fraction. At least 2,000 gallons per day of makeup water will be required. These requirements may vary depending on the size of the HPSA units used on any particular project.

4.2 Expected Results

4.2.1 Bench Scale Testing

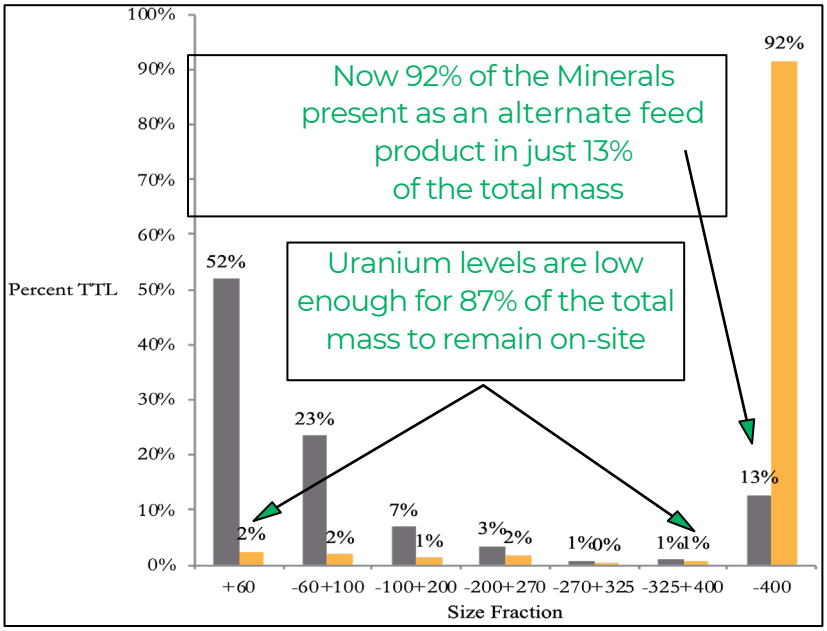
Bench scale testing waste rock using HPSA has been validated on numerous sites throughout the Western U.S. including validation from Idaho National Laboratory. Results are presented in Figures 4-2 and 4-3 that show pre-ablation data and post-ablation data, respectively.

Figure 4-2: Pre-Ablation Mass and Mineral Distribution



Source: Disa, 2022a

Figure 4-3: Post-Ablation Mass and Mineral Distribution



Source: Disa, 2022a

Generally, Disa expects that the HPSA technology will collect approximately 90% of the source material in the isolated mineral fraction (< No. 270 sieve), while 80% to 90% of the mass remains with the clean coarse fraction. This type of waste minimization is a critical aspect of uranium mine reclamation because the use of HPSA drastically reduces the amount of material that must be transported offsite and produces an inert material for reuse onsite. Furthermore, because source material is retained in the isolated mineral

fraction, utilization as an alternate feed at a uranium recovery facility will be more efficient and produce significantly less waste.

4.2.2 Radiological and Metals Comparisons

Disa performed a series of comparisons between the waste rock and clean coarse fraction to determine the net decreases in radiological and toxicity signature. Table 4-1 presents the radiological and mineralogical data, and Table 4-2 presents results of Toxic Characteristic Leaching Procedure (TCLP) for both the waste rock and clean coarse fraction. These data were collected at the request of the Colorado Department of Public Health and Environment and were submitted on February 7, 2022 (Disa, 2022b).

Table 4-1: Radiological Characteristics

Parameter	Units	Waste Rock	Clean Coarse Fraction	Total Reduction	Percent Reduction
Lead -210	pCi/g	149	37.1	111.9	**75.10%**
Radium-226	pCi/g	125	70.4	54.6	**43.68%**
Radium-228	pCi/g	1.9	1	0.9	**47.37%**
Thorium-230	pCi/g	153	74.7	78.3	**51.18%**
Thorium 232	pCi/g	ND	ND	NA	NA
Vanadium	mg/kg	1,362	409	953	**70%**
Uranium	mg/kg	912	129	782	**86%**

Table 4-2: Toxicity Characteristics

Parameter	Units	Waste Rock	Clean Coarse Fraction	RCRA Standard
Arsenic	mg/L	0.3	**ND**	5
Barium	mg/L	2.7	**1.2**	100
Cadmium	mg/L	0.08	**ND**	1
Chromium	mg/L	ND	**ND**	5
Lead	mg/L	ND	**ND**	5
Mercury	mg/L	ND	**ND**	0.2
Selenium	mg/L	ND	**ND**	1
Silver	mg/L	ND	**ND**	5

4.3 Controlled Areas During Remediation

As discussed in Section 4.1, Disa will establish restricted areas at each worksite. Generally, the restricted area will encompass the following operations: crushing and grinding, ablation, isolated mineral fraction storage, and staging areas. Disa will establish a restricted area by erecting a temporary boundary consisting of posts or drums that will support a rope or another type of physical barrier. Attached to the rope with standard yellow and magenta radioactive materials warning signs stating, ”Caution – Radioactive Materials.”

Only authorized users will be allowed to enter the restricted area. Personnel entering the restricted area will be required to don all necessary personal protection equipment (PPE) pursuant to the operational radiation protection plan and site-specific health and safety plans. All personnel entering the restricted area will be required to scan out when leaving the area to minimize potential contamination. Eating, drinking, and smoking are prohibited within the restricted area. However, drinking from a container that can be sealed will be allowed, to avoid the effects of heat stress and dehydration.

4.4 Radiation Surveys and Instrumentation

Disa will perform certain radiation surveys for the following purposes:

- Protection of workers;
- Protection of the public;
- Prevention of contamination to soil;
- Monitoring of air quality for calculating doses to members of the public;
- Monitoring of air quality for calculating doses to workers;
- Compliance with US Department of Transportation (USDOT) shipping regulations; and,
- Pre- and post-operational soil surveys to ensure that the HPSA operations did not contaminate a site.

Procedures for conducting contamination surveys are found in the Standard Operation Procedure (SOP) **Radiation Contamination Surveys and Decontamination**.

Personnel contamination surveys will be performed on all personnel leaving the restricted area. In addition, equipment used within the restricted area will be surveyed for unrestricted use prior to release from the site. The following meters will commonly be used for personnel and equipment release contamination surveys.

- Ludlum 2360 with a Ludlum 43-90 alpha/beta probe
- Ludlum 2929 with a Ludlum 43-10-1 tray counter

Instruments and calibration schedules are provided in Table 4-3. In general, instruments will be calibrated by the manufacturer. If specific models are not available, equivalent, or similar models will be used.

Table 4-3. Instrumentation and Calibration Frequency

Manufacturer	Model Number	Radiation Detected	Sensitivity/Efficiency (4π)	Calibration Frequency
Ludlum	2360/43-93	Alpha, Beta	15% (^{99}Tc) 20% (^{239}Pu, ^{90}Sr/^{90}Y)	Annual
Ludlum	2929/43-10-1	Alpha, Beta	39% (^{238}U), 32% (^{230}Th), 37% (^{239}Pu)	Annual
Ludlum	2221/44-10	Gamma	900 cpm/R/hr	Annual
Ludlum	19	Exposure Rate	0-5,000 µR/hr	Annual
MSA	Escort ELF	Alpha, Beta (Breathing Zone)	1-3 LPM, ± 2.5%	Annual
F&J	LV-1	Air Sampler	10-100 LPM	Annual

SECTION 5.0 RADIATION PROTECTION PROGRAM (FORM ITEMS 10 AND 11)

5.1 General

Disa is committed to the protection of its personnel, the public, and the environment from the effects of radiation. The Radiation Protection Program (RPP) presented in this document shall be implemented to provide radiation protection to employees, project personnel, the public, and the environment while working with radioactive materials on sites where Disa's technology is being used for reclamation/remediation purposes.

This program includes the radiation safety organization and responsibilities, occupational health physics monitoring, exposure control measures, internal and external exposure protection, radiation safety training, radiation work permits, controlled area designation, and record keeping. This program complies with applicable requirements set forth in 10 CFR 20 and 40.

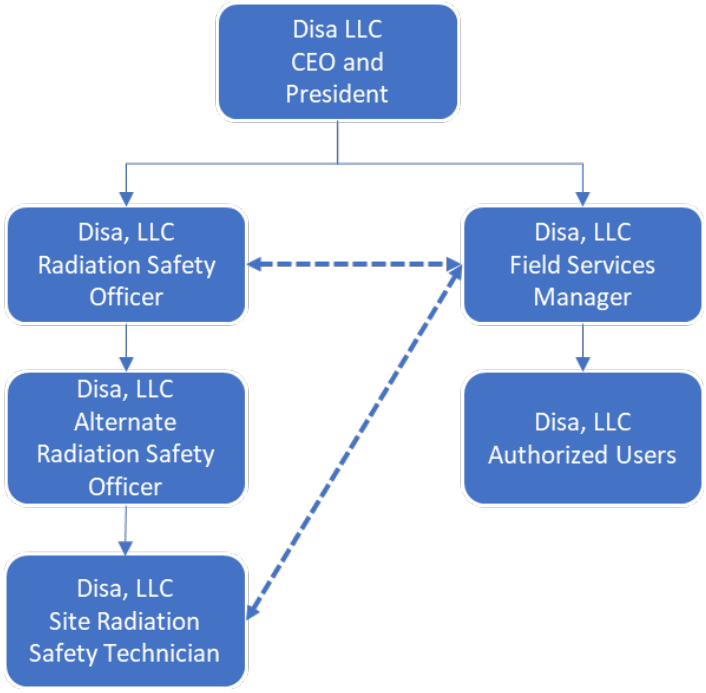
5.2 As Low As Reasonably Achievable (ALARA) Policy

Disa's policy is to maintain radiation exposure to personnel and the general public to levels that are "As Low As Reasonably Achievable" (ALARA) from the maximum limits specified in 10 CFR 20. Disa shall implement its ALARA policy by training all personnel for radiation safety, implementing SOPs, using appropriate control measures, Radiation Work Permits (RWPs), good housekeeping practices, administrative control limits, and radiation protection equipment, as needed. These elements of the ALARA policy are integrated in this Radiation Protection Program to maintain the radiation exposure ALARA.

5.3 Radiation Safety Organization

All Disa personnel and contractors shall adhere to the RPP and the ALARA policy. All individuals involved with radiation-related activities have responsibility for radiation safety. The Radiation Safety Organization will include the CEO/President of Disa, the RSO, ARSO (when one is appointed), Field Services Manager (FSM), and Authorized Users (AUs). Figure 5-1 is an organization chart for Disa's Radiation Safety Organization. As shown in Figure 5-1, the RSO and the FSM both report to the CEO/President; however, both will communicate regarding the implementation of the RPP. Furthermore, the RSO has independence and authority to implement appropriate radiation procedures and controls.

Figure 5-1: Organization Chart



5.4 Qualifications of Radiation Protection Staff

Qualifications for the radiation protection staff are based on Regulatory Guide 8.31, Revision 1 (RG 8.31) (NRC, 2002).

5.4.1 Radiation Safety Officer

- Education: A bachelor's degree in the physical sciences, industrial hygiene, or engineering from an accredited college or university or an equivalent combination of training and relevant experience in facility radiation protection. Two years of relevant experience are generally considered equivalent to 1 year of academic study.
- Health Physics Experience: At least 1 year of work experience relevant to radiation operations in applied health physics, radiation protection, industrial hygiene, or similar work. This experience should involve actually working with radiation detection and measurement equipment, not strictly administrative or "desk" work.
- Specialized Training: At least 1 week of specialized classroom training in health physics specifically applicable to managing source material and RSO training. In addition, the RSO should attend refresher training on source material facility health physics every 2 years.
- Specialized Knowledge: A thorough knowledge of the proper application and use of all health physics equipment used in a source material facility, the chemical and analytical procedures used for radiological sampling and monitoring, methodologies used to calculate personnel exposure to uranium and its daughters, and a thorough understanding of the HPSA process and

equipment used in the facility and how the hazards are generated and controlled during the source material process.

Disa understands that the RSO and ARSO specialized training requirement is less than that stated in RG 8.31 (NRC, 2002). However, Disa determined that its operations are substantially simpler than uranium recovery facilities, for which RG 8.31 was written. Because of Disa's relatively simple operations, a lower degree of specialized training is suitable and warranted. Disa requests the ability for its Safety and Environmental Review Panel to appoint the RSO and ARSO. For the first RSO appointment, Disa will utilized the services of a contract Certified Health Physicist (CHP) to approve the RSO appointment.

5.4.2 Alternate Radiation Safety Officer

- Education: A bachelor's degree in the physical sciences, industrial hygiene, or engineering from an accredited college or university or an equivalent combination of training and relevant experience in facility radiation protection. Two years of relevant experience are generally considered equivalent to 1 year of academic study.
- Health Physics Experience: At least 1 year of work experience relevant to radiation operations in applied health physics, radiation protection, industrial hygiene, or similar work. This experience should involve actually working with radiation detection and measurement equipment, not strictly administrative or "desk" work.
- Specialized Training: At least 1 week of specialized classroom training in health physics specifically applicable to managing source material and RSO Training. In addition, the RSO should attend refresher training on source material facility health physics every 2 years.
- Specialized Knowledge: Knowledge of the proper application and use of some health physics equipment used in a source material facility, methodologies used to calculate personnel exposure to uranium and its daughters, and knowledge of the HPSA process and equipment used in the facility and how the hazards are generated and controlled during the source material process.

5.4.3 Site Radiation Safety Technician

At least one Disa employee will serve as the Site Radiation Safety Technician (RST) during any operation. This person shall have one of the following combinations of qualifications:

1. Combination 1

- Education: An associate degree or 2 or more years of study in the physical sciences, engineering, or a health-related field;
- Training: At least a total of 4 weeks of generalized training (up to 2 weeks may be on-the-job training) in radiation health protection applicable to HPSA processes; and,
- Experience: One year of work experience using sampling and analytical laboratory procedures that involve health physics, industrial hygiene, or industrial safety measures to be applied in a source materials facility.

2. Combination 2

- Education: A high school diploma;

- Training: A total of at least 3 months of specialized training (up to 1 month may be on-the-job training) in radiation health protection relevant to source material facilities;
- Experience: Two years of relevant work experience in applied radiation protection; and,
- The health physics technician should demonstrate a working knowledge of the proper operation of health physics instruments used in the HPSA process, surveying and sampling techniques, and personnel dosimetry requirements.

5.4.4 Authorized Users

Disa will also assign Authorized Users who will implement the Radiation Protection Program on a project site. Authorized users may be authorized and/or removed by the Disa RSO upon review of their qualifications.

5.5 Responsibilities

All personnel are responsible for radiation protection and implementation of ALARA policy. Personnel will direct responsibility for implementing the Disa license and maintaining compliance with the NRC regulations are the RSO, ARSO, the Field Services Manager, and Authorized Users.

5.5.1 Management

Disa's management will have the following responsibilities, based on RG 8.31 (NRC, 2002):

- Expressing in writing, a strong commitment to and continuing support for the development and implementation of the radiation protection and ALARA program;
- Providing information and policy statements to employees, contractors, and visitors;
- Implementing a periodic management audit program that reviews procedural and operational efforts to maintain exposures ALARA;
- Implementing a continuing management evaluation of the radiation safety (health physics) program, its staff, and its allocation of adequate space, and money; and,
- Providing appropriate briefings and training in radiation safety, including ALARA concepts for all remediation employees in the facility and, when appropriate, for contractors and visitors.

5.5.2 Radiation Safety Officer

The Disa RSO ("license-designated RSO") has the following responsibilities:

- Serving as the primary point-of-contact on the license;
- Primarily responsible for overseeing and implementing the RPP and ALARA policy at each Disa temporary project site;
- Communicating responsibilities with the FSM and AUs;
- Developing and implementing training programs for the AUs and RSTs;
- Ensuring all training is current;

- Maintaining records in accordance with NRC regulations after the completion of work at temporary project sites;
- Investigating incidents and serving as the primary point-of-contact for all incidents;
- Review the RPP and its implementation annually;
- Properly handling, management, and offsite shipment of all source material;
- Review the RPP and its implementation annually;
- Establish occupational health physics and radiological monitoring procedures for site activities;
- Review radiological monitoring data to evaluate exposures and assure that any radiation exposures are ALARA;
- Provide the exposure and monitoring data to the appropriate regulatory agencies and the individual in accordance with applicable rules or regulations; and,
- Implement and maintain an effective respiratory and bioassay program, as required.

5.5.3 Alternate Radiation Safety Officer

The Disa ARSO will support the RSO in execution of the RPP and ALARA program at each Disa temporary project site. The ARSO's responsibilities will be those delegated by the RSO, which could include:

- Implement the RPP and the ALARA Policy;
- Communicating responsibilities with the FSM and AUs;
- Developing and implementing training programs for the FSM and AUs;
- Ensuring all training is current;
- Maintaining records in accordance with NRC regulations after the completion of work at temporary project site;
- Investigating incidents and serving as the primary point-of-contact for all incidents;
- Review the RPP and its implementation annually;
- Properly handling, management, and offsite shipment of all source material;
- Establish occupational health physics and radiological monitoring procedures for site activities;
- Review radiological monitoring data to evaluate exposures and assure that any radiation exposures are ALARA;
- Implement and maintain site-specific dosimetry programs; and,
- Implement and maintain an effective respiratory and bioassay program, as required.

Regardless of the responsibilities delegated to the ARSO, the RSO maintains ultimate responsibility for the compliance with the license, implementing the RPP, and implementing the ALARA policy.

5.5.4 Field Services Manager

The FSM will be an AU on all project sites. The FSM shall have the primary responsibility for overseeing and implementing the RPP and ALARA policy on project sites. Specific responsibilities are, as follows:

- Coordinate with the RSO, ARSO, and Site Radiation Safety Technician to ensure compliance with RPP procedures, license conditions, emergency plans, training requirements, etc.;
- Coordinate with the Site Radiation Safety Technician to implement the RPP, along with radiation safety procedures;
- Coordinate with Site Radiation Safety Technician to evaluate control measures with appropriate managers to maintain radiological exposures ALARA;
- Advise and instruct personnel concerning performance of their radiation safety responsibilities;
- Observe site activity to ensure compliance with the RPP and the ALARA policy; and,
- Maintain records of radiological monitoring and exposures during the duration of a project.

5.5.5 Site Radiation Safety Technician

- Implement and oversee the RPP, along with radiation safety procedures;
- Implement ALARA policy;
- Review radiological monitoring data to evaluate exposures and assure that any radiation exposures are ALARA;
- Implement and maintain a dosimetry program;
- Perform radiological contamination surveys of equipment and materials released to the unrestricted areas;
- Assure that decontamination and release of equipment and material complies with the requirements;
- Stop work activity if there is a potential for inadvertent excessive radiation exposure to personnel, the general public, or the environment;
- Maintain records of radiological monitoring and exposures during the duration of a project; and,
- Assure that all radiation survey instruments are properly calibrated.

5.5.6 Authorized Users

Each AU is responsible for understanding and adhering to the RPP and the ALARA policy, and pursuant to the Disa Health and Safety Program all employees have Stop Work Authority. Personnel shall be required to understand, by training, the radiological conditions of the specific site or area to which they are assigned. Individuals shall stop working if situations or conditions arise that might adversely affect radiation exposures and must notify the FSM and the RSO/ARSO for evaluation of the situation or condition prior to resuming work. Each individual shall be required to report any condition that may lead to a violation of the RPP to the FSM or the RSO/ARSO. Personnel shall be advised of their rights 10 CFR 19, such as instructions, notifications, reports, and request for inspections. Any violation of the RPP by any individual may result in disciplinary action.

5.6 Safety and Environmental Review Panel

Because Disa is seeking a performance-based license, Disa will establish a Safety and Environmental Review Panel (SERP) to oversee changes, tests, and experiments to be performed under Disa's license. Disa's SERP will consist of at least three individuals:

- The Chief Operating Officer, or another higher-level operations person, will be a member of the SERP and will have expertise in operations and/or construction and will have responsibility for implementing any operational changes.
- The Chief Executive Officer, or a higher-level manager, will be a member of the SERP and will have expertise in management and will be responsible for implementing managerial and financial changes.
- The RSO will be a member of the SERP with the responsibility for assuring that changes conform to radiation safety and environmental requirements.

Additional members may be included in the Safety and Environmental Review Panel, as appropriate, to address specific technical issues such as health physics, ground-water hydrology, surface-water hydrology, and specific earth sciences or other technical disciplines. Temporary members may include consultants. A description of when additional members will be used is provided. Disa will prepare a procedure that describes the manner in which the SERP will operate.

5.7 Radiation Dose Limits

5.7.1 Occupational Dose Limits

Consistent with 10 CFR 20.1201, the dose limits from occupational exposure to radiation are as follows:

- The annual limit is the more limiting of:
- The total effective dose equivalent equal to 5 rem.
- The sum of the deep-dose equivalent and committed dose equivalent to any individual organ equal to 50 rem.
- The annual limits to the lens of the eye and to the skin are:
- An eye dose equivalent of 15 rem.
- A shallow-dose equivalent of 50 rem to the skin or to any extremity.

5.7.2 Occupational Dose Limits to Minors

Pursuant to 10 CFR 20.1207, the annual occupational dose limits for a minor (under the age of 18 -years) are 10 percent of the annual dose limits for an adult as set forth in 10 CFR 20.1201. The Disa RSO shall review minors' work assignments to assure that any exposures are maintained ALARA.

5.7.3 Dose Limit to an Embryo/Fetus

Pursuant to 10 CFR 20.1208, the radiation dose limit to an embryo/fetus during entire pregnancy, due to occupational exposure of a declared pregnant woman, shall be 0.5 rem (500 mrem). Disa shall inform all female personnel of their right to notify the Disa RSO in writing of their pregnancy immediately upon knowledge or suspicion of pregnancy. The RSO, ARSO, and FSM shall review work assignments of any

declared pregnant woman to assure that the embryo/fetus dose does not exceed the 0.5 rem limit and is maintained ALARA.

5.7.4 Planned Special Exposures

Due to low levels of radioactivity associated with Disa's licensed material and with the project sites on which Disa works, no planned special exposures are expected. If circumstances warrant a planned special exposure, the Disa RSO shall authorize such exposures consistent with the requirements of 10 CFR 20.1206.

5.7.5 Summation of External and Internal Doses

Pursuant to 10 CFR 20.1502, if it is determined that both the internal radiation dose from air sampling measurements, and the external radiation dose from dosimeters, is likely to exceed 10 percent of the limit, the committed effective dose equivalent (CEDE) and Deep Dose Equivalent (DDE) shall be summed. This shall demonstrate compliance with Total Effective Dose Equivalent (TEDE) limit.

If routine air sampling and dosimeter results indicate that the dose from either internal or external radiation exposure could exceed 10 percent of the limit, the summation requirements of internal and external radiation doses under 10 CFR 20.1202. The sum of the DDE (mrem, as determined by dosimeter) divided by 5000 (mrem, TEDE) and the total number of Derived Air Concentration (DAC) hours for all radionuclides divided by 2,000 may not exceed one.

5.7.6 Determination of Prior Occupational Dose

If any individual is likely to receive in one year an occupational dose in excess of 10 percent of the limit, Disa shall determine the individual's prior occupational dose as follows:

- A determination shall be made based on information on the nature and the amount of prior occupational dose disclosed in a signed statement from the individual or from the individual's most recent employer for work involving radiation exposure for the current year.
- Disa shall attempt to obtain the records of life-time cumulative occupational radiation dose in the NRC Form 4 or an equivalent form, signed by the individual and countersigned by an appropriate representative of the most recent employer for any work involving radiation exposure.

5.7.7 Radiation Dose Limits for Individual Members of Public

The dose limits for individual members of the public shall be consistent with 10 CFR 20.1301, as follows:

- Total effective dose equivalent of 0.1 rem (100 mrem) per year to individual members of public; and
- Maximum dose rate of 0.002 rem/hour in the unrestricted area from external radiation sources.
- If any member of the public enters any controlled area, which is isolated outside the restricted area, the above dose limits shall apply.

5.7.8 Compliance with Dose Limits for Individual Members of Public

Normal operations and activities at Disa project sites are not expected to expose members of the public or release effluents. Where required, compliance shall be achieved through the monitoring of airborne particulate and gases released from a site, as well as direct gamma radiation measurements from environmental dosimeters, where appropriate. Disa shall demonstrate compliance with dose limits for individual members of the public as specified in 10 CFR 20.1302.

5.8 Radiation Safety Training (Form Item 8)

Disa requires that all individuals working in or frequenting any portion of a restricted area shall be:

- Kept informed of the storage, transfer, or use of radioactive materials or of radiation in such portions of the restricted area.
- Instructed in the health protection problems associated with exposure to such radioactive materials or radiation, in precautions or procedures to minimize exposure, and in the purposes and functions of protective devices employed.
- Instructed in, and instructed to observe, to the extent within the individual's control, the applicable provisions of NRC regulations and licenses for the protection of personnel from exposures to radiation or radioactive materials occurring in such areas.
- Instructed of their responsibility to report promptly to the licensee any condition which may lead to or cause a violation of NRC regulations and licenses or unnecessary exposure to radiation or to radioactive material.
- Instructed in the appropriate response to warnings made in the event of any unusual occurrence or malfunction that may involve exposure to radiation or radioactive material.
- Be advised as to the radiation exposure reports which personnel may request pursuant to 10 CFR 19.

The extent of these instructions shall be commensurate with potential radiological health protection problems in the restricted area.

The RPP is most effective when each individual is aware of radiation hazards. All individuals shall be trained based on their work assignments. The following topics shall be included in the radiation safety training for personnel completing field work:

- Fundamentals of Health Protection
- Radiological and toxic hazards of exposures to radioactive materials
- Pathways of radioactive material into the body
- ALARA policy for exposure to radioactive materials
- Radiation Protection and Personal Hygiene
- Protective clothing
- Proper use of respirators
- Eating, drinking, smoking, and chewing in designated clean areas only

- RWP and access controls
- Methods of personnel decontamination
- Ventilation system and efficient control measures
- Engineering controls
- Health Physics Monitoring
- Airborne radioactive material measurement
- Bioassay
- Material and personnel contamination surveys
- External exposure rate survey and personal dosimetry
- Radiation Protection Regulations
- Regulatory authority of NRC
- Worker rights in 10 CFR Part 19
- Radiation protection requirements in 10 CFR Part 20
- Emergency Procedures

All individuals shall be tested for comprehension of radiation safety training by a written test and must pass the test in order to work in the restricted area. The FSM shall assure personnel have passed the test before the individual is permitted into the work restricted area. AUs under Disa's radioactive materials license will be trained to the level required under the license, and as stipulated in the license application.

5.9 Radiation Work Permit

If there is a potential for significant exposure to radiation during non-routine activities within the restricted area for which no SOP exists, the work shall be conducted under a Radiation Work Permit (RWP). RWPs control radiation exposure by radiological protection and monitoring to maintain radiation exposures ALARA. An RWP shall be requested by the FSM for the activity to be performed and shall be authorized and approved by the RSO/ARSO. The FSM shall assure that any activity that requires an RWP is not performed until an RWP is obtained.

Personnel involved with the activity shall be given specific instructions for that activity so that they shall be aware of the hazards and understand the use of special radiation protection equipment. Radiological data from prior activity and other operational surveys shall be used for preparing the RWP. The RWP shall include the location and description of activity, name of the FSM that requested the RWP, and all individuals involved, radiological protection equipment, special monitoring, special instructions, date of issue and expiration, radiation surveys and levels, and approval of the RSO. Only the RSO/ARSO can terminate an RWP prior to the expiration date and only after determination that the radiological levels are below the control limits and are stable.

The area where the activity is conducted under the RWP shall be designated as a controlled area and may be isolated within the restricted area. Access shall be limited to those individuals who are trained in and involved with the activity work in order to control exposures and minimize the spread of radiological contamination.

5.10 Release of Equipment and Material

The release of facilities, equipment, and material to an unrestricted area shall comply with Disa SOP, ***Radiological Contamination Surveys and Decontamination***. All materials and equipment used for work in the restricted area shall be presumed contaminated unless the surface contamination levels meet the criteria for release to the unrestricted area.

5.11 Health Physics Monitoring Procedures and Calibration

All procedures used by Disa for radiation surveys and health physics monitoring shall have sufficient sensitivity requirements to meet the objectives of the survey or monitoring. Radiological field and laboratory analysis instrumentation shall be calibrated using National Institute of Standards and Technology traceable standards.

Procedures require calibrations to be performed on an annual basis and function checks to be performed for each day of use. Where licensed radioactive material (i.e., a Th-230 check source) is used for function checks of alpha radiation detection instrumentation, the licensed material will not be removed from the site and will be under the control of the RSO, the ARSO, or an AU. Licensed sources will be stored in a secured and locked location (e.g., safe, or locked building) when not in use.

Personnel who are likely to receive in one year an occupational dose from sources external to the body, a dose in excess of 10% of the applicable regulatory limits in to 10 CFR 20.1201, will be monitored by personnel dosimetry (whole body and extremity if needed). Personnel dosimetry shall be provided by a NVLAP accredited supplier. Personnel will be responsible for wearing dosimetry as directed by the RSO (normally front torso of the body for whole body). The RSO shall conduct dose investigations whenever dosimetry badges are lost, or results have been compromised or are unexpectedly elevated. Area radiation surveys, restricted area access logs, and personnel dosimetry results (including those of co-workers as applicable) may be used for dose investigations.

Female workers who become pregnant are encouraged to declare their pregnancy. A female worker may declare her pregnancy by submitting in writing to the RSO a statement declaring her pregnancy with the estimated date of conception with a signature and date of declaration. Disa will institute radiation control measures to limit the radiation exposure to the unborn fetus to less than 500 mrem for the entire gestation period. Disa's program to provide instructions to females of childbearing age and to control prenatal exposure ALARA will comply with the applicable sections of US NRC Regulatory Guides 8.13 and 8.36.

Additional provisions are as follows:

- No individual under the age of 18 years will be assigned radiation worker duties.
- Workers who have received occupational exposure prior to employment at Disa shall provide their radiation exposure history or request their radiation exposure from previous employers.
- Annual notification of occupational exposure will be provided to radiation workers. The annual notification will be equivalent to the information in NRC Form 5.

5.12 Public Dose and Effluent Monitoring at Project Sites

Members of the public are not permitted to work in restricted areas at project sites at which work is being performed under this license. Radiation exposures to the public will be maintained below 100 mrem/yr total effective dose equivalent (TEDE). Dose rates in unrestricted areas will be less than 2 mrem in any one hour. Public doses will be measured using calculation methods and measurement techniques approved in NUREG-1556, Volume 12, Appendix J (NRC, 2018b). Dose to the public as a result of airborne effluent (excluding radon) will be limited to 10 mrem/yr TEDE.

5.13 Transportation of Radioactive Materials

Transportation of radioactive (Class 7) material will follow the USDOT regulations. Personnel performing hazardous material shipping will receive initial training in accordance with 49 CFR 172 and recurrent training every three years. Packages containing radioactive material shall be surveyed for radiation levels and contamination as specified in regulations and Disa SOPs (***Shipping UN2910 Radioactive Material, Transport of Uranium Source Material as LSA-1,*** and ***Radioactive Material Receipt***). Labeled radioactive material packages (except for special form and gases) must be surveyed within 3 hours of receipt if the package is received during normal working hours or within 3 hours for the beginning of the next scheduled workday if delivered after working hours.

5.14 Radioactive Waste Management (Form Item No. 11)

Depending on the client, Disa will either generate one waste stream or no waste streams. The complete list of materials generated and an assessment of whether the materials are waste or not is presented below in Table 5-1.

Table 5-1: Disa Materials Output and Waste Designation

Material	Radioactive Waste (Y/N)	Rationale
Isolated Mineral Fraction	Both	Yes, if the material is disposed of a low-level radioactive waste. No, if the material is utilized as alternate feed.
Clean Coarse Fraction	No	Material is inert and can be used onsite for reclamation.
Water	No	Water is treated to 10 CFR 20, Appendix B standards and discharged.
Water Treatment Solids	Both	Yes, if the material is disposed of a low-level radioactive waste. No, if the material is utilized as alternate feed.

A review of Table 5-1 indicates that two streams could be radioactive waste is the customer mandates that materials be disposed at a low-level radioactive waste facility instead of being utilized as alternate feed. Regardless of the final fate of all streams, Disa's radioactive waste management program will consist of transporting the product at a licensed uranium recovery facility, treating and discharging water, or transporting liquids and solids to licensed disposal facilities. Liquids treatment will be designed to meet

10 CFR Part 20, Appendix B effluent standards, and Disa will not discharge treated water directly to surface water. Waste will be managed in accordance with Disa SOP ***Radioactive Materials and Waste Storage***.

Isolated mineral fraction will be collected in a lined dump trailer or lined roll-off container and stored in restricted areas, under the direct control of the FSM and AUs. Disposal/utilization of source material will be through commercial licensed waste disposal facilities. The primary destination for all source material a licensed uranium recovery facility, for utilization as an alternate feed. In the event a licensed uranium recovery facility not available, then the source material will be disposed at a licensed, low-level radioactive waste disposal facility. Collection, packaging, labeling, and transportation of wastes will be in accordance with USDOT regulations. The RSO, ARSO, or FSM are responsible for oversight of proper waste packaging, labeling, transportation, and disposal record maintenance.

Contaminated liquids will be stored in the Process Water Tank. The primary option for disposing of contaminated water is to treat the water, collect samples, and release the water to the ground surface. If this is not possible, water will be transported to a licensed disposal facility. The total amount of water utilized for each project varies based on the size of the HPSA unit deployed. Each unit that is deployed will be engineered to use as little water as possible. Water loss occurs during the dewatering stage as moisture in the isolated mineral fraction and the clean coarse fraction (~20%). Therefore, water is added on a continuous basis. Because dewatering will involve filter presses and centrifuges, no free liquids will remain in the clean coarse fraction.

If Disa chooses to discharge the water, the amount of radioactivity that can be discharged will be determined from 10 CFR 20, Appendix B effluent standards. Water samples will be analyzed during each project to determine compliance with the Appendix B standards. Disa will only discharge water that complies with the effluent standards and will not discharge any water to surface water bodies. Records of the disposal will include dates, radionuclide concentrations, and other constituent concentrations (as needed) based on the analysis of treated water.

Disa will secure the offsite shipment of all source material and liquid waste prior to completely demobilizing from a project site. No long-term storage of source material or liquid waste will occur at a project site. When disposing/utilizing source material or liquid waste offsite, Disa will verify that the licensed recipient is authorized to receive the radioactive material prior to shipping. Disa will provide all information required in NRC's Uniform Low level Radioactive Waste Manifest and transfer this information to the recipient. Disa will also obtain the necessary permits from the Rocky Mountain Low Level Radioactive Waste Board to export radioactive waste, if necessary.

Material and equipment that has been decontaminated will be surveyed for unrestricted release and/or disposal in an authorized disposal facility. All radioactive material signs will be removed or obliterated from material and equipment that have been released prior to disposal.

5.15 General Guidelines for Waste Management

1. All radioactivity labels must be defaced or removed from containers and packages prior to disposal into ordinary "non-radioactive" waste streams. If waste is compacted, all labels that are visible in the compacted mass must be defaced or removed.
2. Remind workers that nonradioactive waste, such as leftover reagents, boxes, and packaging material, should not be mixed with radioactive waste.
3. Radioactive waste must not be stored near explosive materials.

4. Occasionally review all procedures to ensure that radioactive waste is not created unnecessarily. Review all new procedures to ensure that waste is handled in a manner consistent with established procedures.
5. In all cases, consider the entire impact of various available disposal routes. Consider occupational and public exposure to radiation, other hazards associated with the material and routes of disposal (e.g., toxicity, carcinogenicity, pathogenicity, inflammability), and costs.

5.16 Records and Reports

Records of radiological monitoring, surveys, exposures, calibrations, reports, inspections, training, investigations, corrective actions, and records of reports shall be maintained according to requirements in 10 CFR 20 and 40.

5.16.1 Personnel Exposure and Dosimetry Records

Personnel records will be maintained for the life of the company, and personnel may review their file or request copies of information within their files. The licensee for which work is performed will be provided individual exposure information as required by their license or applicable regulations. The personnel records that will be maintained include:

- A record of individual radiation exposure received during previous employment will be maintained by requesting personal exposure information from previous employers where the individual worked with radioactive materials.
- A record of personnel dosimetry results during the course of Disa work assignments.
- If a personal dosimeter is lost or damaged, an exposure investigation will be performed, and an exposure will be assigned for the monitoring period.
- If the air concentration in the work area exceeds 10% of applicable 10 CFR 20, Appendix B DAC values, air samples and bioassay samples may be used to estimate and document internal exposures received by the worker.

5.16.2 Survey Records

Survey records collected during site surveys, remediation/decontamination activities, and radiological characterization activities will be maintained by the project radiation safety staff.

5.16.3 Waste Disposal and Material Transfer

Radiation survey records, shipping manifests and certifications generated for a licensee's shipment of radioactive materials to a licensed disposal site shall be maintained by the project radiation safety staff.

5.16.4 Reporting to the NRC

The NRC staff will be notified of defects and non-compliance in accordance with Table 5-2. This table provides notification time frames for both telephone notification and written report.

Table 5-2: Reporting Requirements for NRC Notification

Event	Telephone Notification	Written Notification
Theft or loss of material	Immediate	30 days
Whole body dose greater than 0.25 Sv (25 rem)	Immediate	30 days
Extremity dose greater than 250 rem	Immediate	30 days
Whole body dose greater than 5 rem	24 hours	30 days
Extremity Dose greater than 50 rem	24 hours	30 days
Dose to an individual member of the public greater than 100 mrem	None	30 days
Defect in equipment that could create a substantial safety hazard	2 days	30 days
Filing a petition for bankruptcy under 11 U.S.C.	None	Immediately after filing petition
Expiration of License	None	60 days
Decision to permanently cease all licensed activities at an entire site	None	60 days
Decision to permanently cease licensed activities in any separate building or outdoor area that is unsuitable for release for unrestricted use	None	60 days
No principal activities conducted for 24 months at an entire site	None	60 days
No principal activities conducted for 24 months in any separate building or outdoor area that is unsuitable for release for unrestricted use	None	60 days
Event that prevents immediate protective actions necessary to avoid exposure to radioactive materials that could exceed regulatory limits	Immediate	30 days
Equipment is disabled or fails to function as designed when required to prevent radiation exposure in excess of regulatory limits	24 hours	30 days
Unplanned fire or explosion that affects the integrity of any licensed material or device, container, or equipment with licensed material	24 hours	30 days

5.16.5 Standard Operating Procedure List

Table 5-3 contains a list and a description of the standard operating procedures. This list may be updated as necessary for additional SOPs. SOPs may be updated and revised via RSO/ARSO approval. Appendix C contains the SOPs.

Table 5-3: Standard Operating Procedures

Title	Summary of Content
ALARA	Program and methods for reducing exposures to ionizing radiation and radioactive material to levels that are as low as reasonably achievable (ALARA)
Operational Checkout of Single-Channel Detector with Meter	Instructions ensuring instruments are operating appropriately.
Operational Checkout of Dual-Channel Alpha/Beta Detector with Meter	Instructions ensuring instruments are operating appropriately.
Guidelines for Handling Radioactive Material	Instructions for handling and using licensed materials.
Radiological Area Access and Posting	Steps to control access to work sites and appropriate posting and signage requirements.
Radiation Contamination Surveys and Decontamination	Methods for conducting radiological contamination surveys for personnel and equipment and appropriate decontamination methods.
Emergency Response	Steps to take and whom to contact when an emergency occurs.
Air Sampling	Procedure for collecting general air sampling and breathing zone air samples.
External Dosimetry	Instructions for issuing and exchanging TLDs / OSLs and dose result handling.
Shipping UN2910 Radioactive Material	Instructions for shipping radioactive materials (e.g., samples) as UN2910, Radioactive Materials, Excepted Package – Limited Quantity of Material.
Transport of Uranium Source Material as LSA-1	Instructions for conducting required surveys to support haul trucks transporting uranium source material as LSA-1 material.
Removable Contamination Swipe and Air Sampling Filter Analyses	Instructions for counting of removable contamination swipes and air sample filters.
Radioactive Materials and Waste Storage	Guidance for storage of radioactive materials and wastes including segregation of materials.
Radiation Safety Training	Describes radiation safety training requirements.
Radioactive Material Receipt	Instructions for surveying and opening radioactive packages upon receipt.
Site Mobilization and Demobilization	Instructions for mobilizing equipment and demobilizing equipment from each site.

5.16.6 Additional Protocol

Pursuant to 10 CFR 40.31, Disa will provide the required information for the Additional Protocol. Required information for the Additional Protocol is found in 10 CFR 75.11, and Form DOC/NRC AP-1 will be used to document this information.

SECTION 6.0 DOSE ASSESSMENT

6.1 Introduction

Disa performed a dose assessment to estimate potential occupational and public doses from licensed operations. External and internal dose contributions were modeled using conservative estimates of parameters (e.g., occupancy, equilibrium, etc.) and expected maximum concentrations of source terms. Conservatism was incorporated into the models due to the uncertainty in many factors including the exact layout of process equipment, variable concentrations, and material densities (e.g., waste rock, slurry, reject, and product mixtures), and source volumes.

A comparison between expected external and internal doses from an existing waste rock pile to the expected doses of the reject pile was performed to show the estimated dose reduction benefit from this technology. Total doses consider both external (gamma) and internal (inhalation) contributions. External dose contributions were modeled using MicroShield (Grove Software, 2022) while the internal dose contribution was modeled using MILDOS (Argonne National Laboratory, 2020).

It is important to note that Disa presents maximum, mean, and median doses in this application. However, maximum doses are based on unreasonable scenarios, which require employees to be standing immediately adjacent to the source terms for extraordinarily long periods of time; this scenario is actually impossible. Mean and median doses are more reasonable but are still highly conservative.

6.2 Dose Assessment Modeling

6.2.1 External Dose

External doses were modeled using MicroShield (Grove Software, 2022). This software is able to model simple shapes and volumes of materials (both shielding and source materials) and provides external exposure rate and absorbed dose rate results. Modeled absorbed doses are related to the reported effective doses via factor 0.7. The nature of Disa's technology involves numerous pieces of complex machinery including a rock crusher, high-pressure slurry ablation unit, and centrifuges. Source material will also maintain a trailer onsite for storage of product source material prior to offsite transportation.

The dose assessment was performed by modeling each component individually, as simple cuboids (rectangular prisms), and then piecing the individual components together to create a spatial map of calculated effective dose rates. A 5 ft by 5 ft grid system (see Figure 6-1) was used to approximate the equipment dimensions and layout. External dose rates were calculated for a given grid by summing dose contributions from nearby components (see Figure 6-2). Modeled components are shown in Table 6-1. Table 6-2 provides details on the various source material types.

Table 6-1: Components Included in External Dose Model as Source Terms

Equipment	Approximate Size (L x W x H), ft[a]	Source Material Type
Crusher and 0.25" Screen	56.5 x 19 x 15.5	Input waste rock
HPSA Unit	30 x 9 x 11	Slurry
Product Centrifuge	16 x 9 x 10	Product stream
Reject Centrifuge	16 x 9 x 10	Reject stream
Transportation Truck Trailer	(24 x 8 x 5.6) x 2	Product Stream
Process Water Tank	24 x 12 x 13	Process water
Process Water Treatment Unit	11 x 8 x 8	Process water
Product Centrifuge Hopper	8 x 5 x 4	Product stream
Product Centrifuge Auger Conveyor	20 x 6 x 1	Product stream
Reject Centrifuge Stacker	35 x 2 x 2	Reject stream

[a] Components were considered rectangular parallelepipeds with the given dimensions.

Table 6-2: Materials Used in the Model

Materials[b]			Activity		
Type	**Properties**	**Density**	**mg U/kg**	**µCi U/cm³**	**pCi/g[a]**
Equipment	*Steel*	8	-	-	-
Input Waste rock	*Iron*	2.3	1500	2.34E-03	1.02E+03
Slurry	*Water*	1.3	1500	1.31E-03	1.02E+03
Product Stream	*Iron*	2.3	7000	1.09E-02	4.74E+03
Reject Stream	*Iron*	2.3	500	7.79E-04	3.39E+02
Process Water	*Water*	1	35	2.37E-05	2.37E+01

[a] Assumes specific activity of 0.677 µCi/g.

[b] Densities and activities are given or calculated.

Figure 6-1: Model Components and Grid System Dose Model

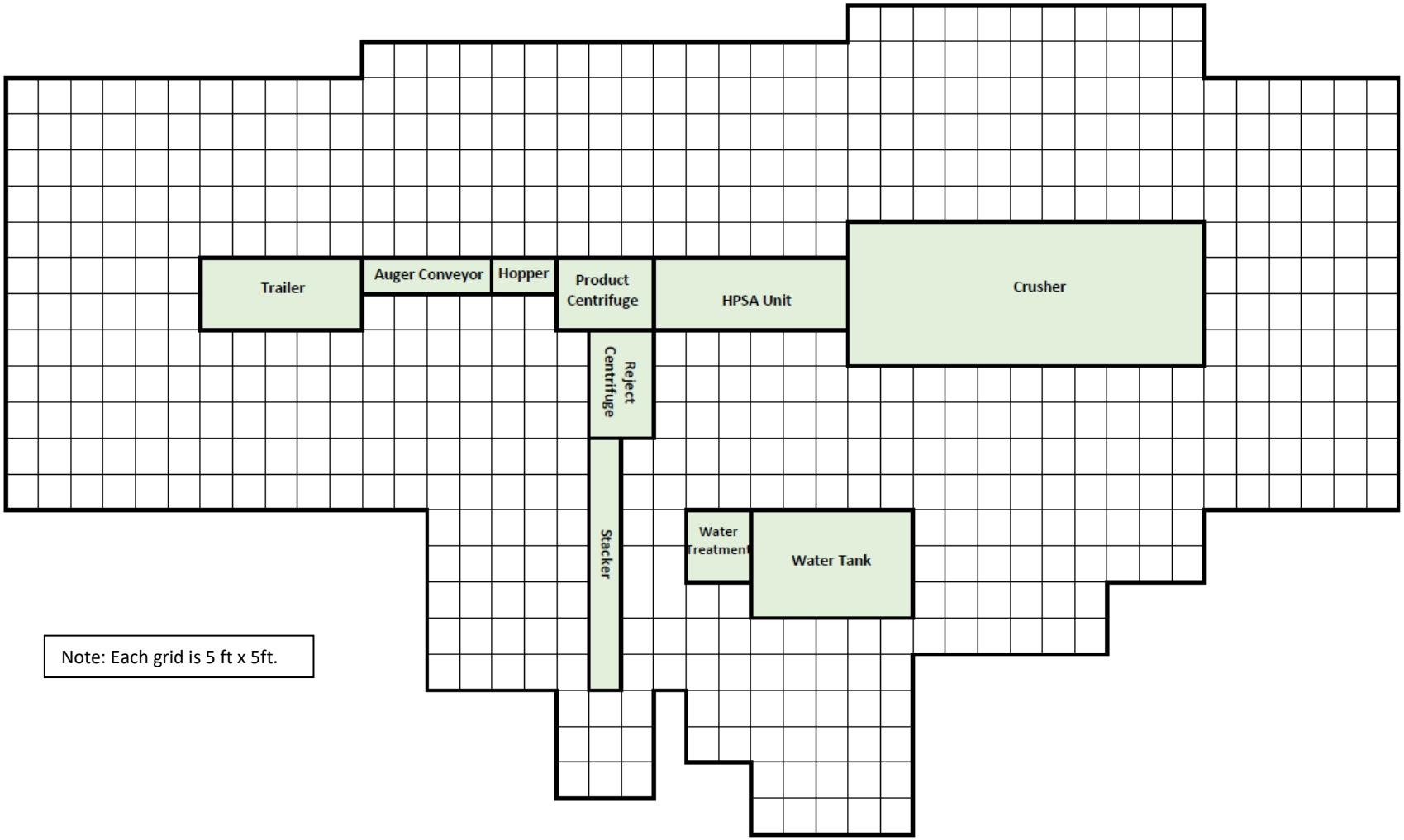
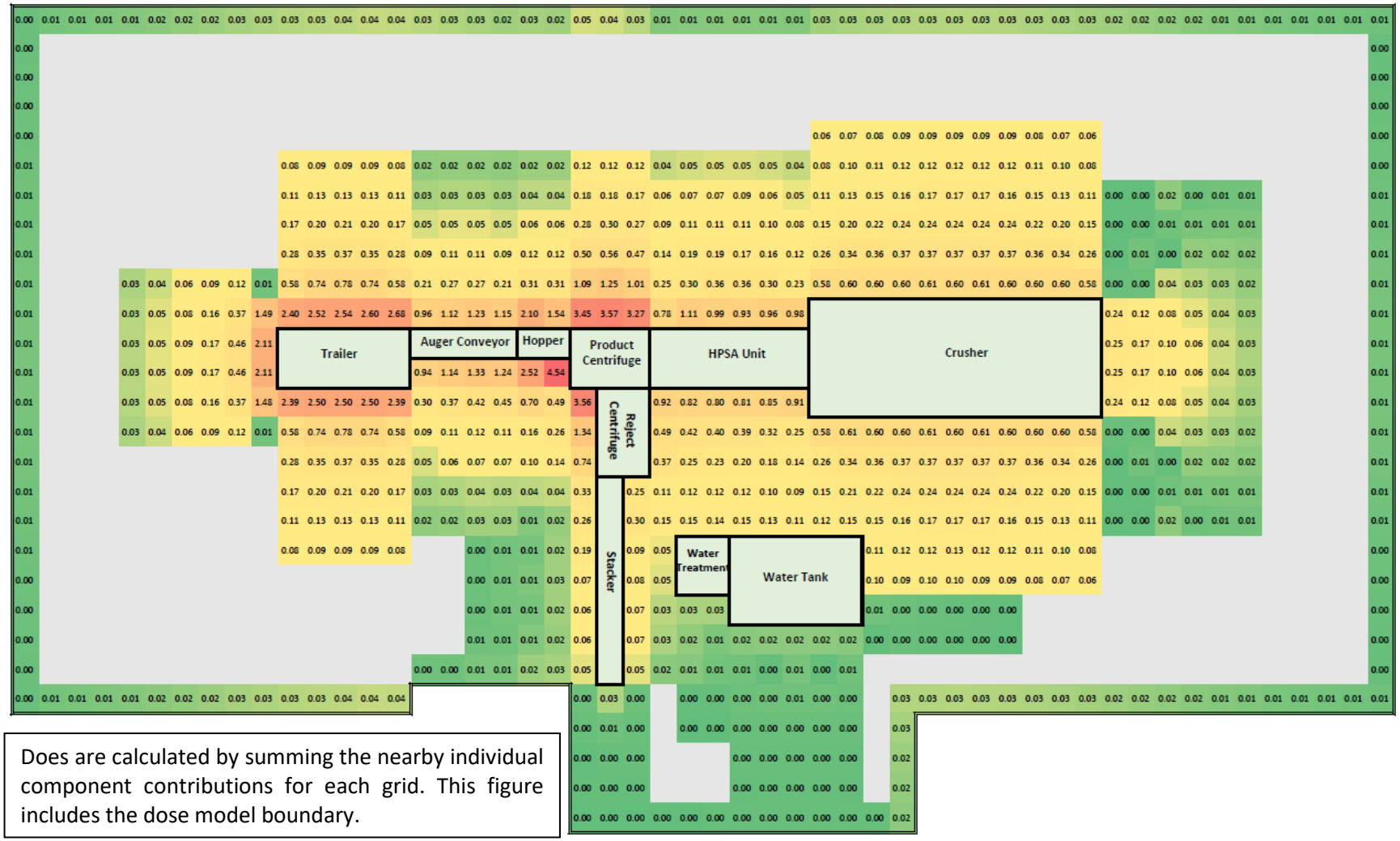


Figure 6-2: Modeled Dose Rates (mrem/hr)



Does are calculated by summing the nearby individual component contributions for each grid. This figure includes the dose model boundary.

Each component (source term) was modeled individually as a solid shape of source material at a particular concentration. Concentrations are dependent on where the source term is in the process. All equipment was assumed to be surrounded with 0.25 inches of stainless-steel shielding. Material properties are used by the software to approximate build-up factors and attenuation characteristics. Iron is a default material in MicroShield and was used as an analog for the waste rock material and process streams. The 40% density by mass solids slurry material was assumed to be similar to water.

6.2.2 Assumptions and Approximations

The following conservative assumptions and approximations were made. These assumptions ensure a large margin of safety in modeled results. Because of this, modeled results represent conditions that are maximum potential values. During normal operation, actual dose rates are expected to be much lower.

- Equipment and Process Layout - Due to the limitations of the modeling software and the grid-system used to combine the results from multiple modeled components, a very rigid layout of components was used. In general, the layout modeled is comparable to expected field conditions; the main process equipment will occur in a linear process train while the reject stream will be directed away from the main product stream. However, actual equipment positions will affect potential occupational and public doses.
- Source Terms - In all cases (internal and external models), it is assumed that uranium is in secular equilibrium with all of its decay progeny. Each source term is modeled as a solid block of source material at a specific concentration. While these dimensions are accurate for considering the footprint and overall volume of space occupied by each component, it is highly unlikely that the volume of source material within each component is accurately represented by the equipment dimensions.

  The actual volume of source material will be some fraction of this total volume. For this model, the source volume was assumed to be 75% of the total volume from Table 1. Equipment often has internal components that occupy space and provide additional shielding. Furthermore, smooth operations of this nature do not allow for components to be completely filled; otherwise, overtopping, or high backpressures could occur. Also, it is likely that the source material will be shielded by more than a single layer of 0.25 steel. However, for the sake of simplicity and conservatism, this factor is ignored.
- Concentrations and Densities - Concentrations of materials are the maximum values expected. These values were determined from field observation and lab-scale testing. Concentrations will vary in reality, but the concentrations used provide an upper bound on modeled dose rates.
- Modeling Extents - As seen in Figure 6-2, occupational dose rates were modeled up to about 20-30 feet from the surfaces of equipment. This is a limiting factor in the model results and is related to the software modeling capabilities. To model the potential public doses, an average distance of 50 feet from equipment was modeled. This distance varies slightly depending on the layout and size of the equipment. This distance represents a potential restricted area, beyond which no members of the public would be allowed access.
- Occupancy - Occupancy times for occupational and public exposures will be highly variable. For occupational doses, it is assumed that a worker will be exposed 8 hours a day, 7 days a week, for 9 months out of the year. Nine months was selected because mobilization, demobilization, time between projects, travel to project sites, weekends, and holidays, will reduce employees

time being exposed to radioactive materials. Consequently, assuming a full year of employee exposure, which is typically assumed, is physically impossible.

A member of the public will be exposed 8 hours a day, 7 days a week, for 6 months of the year. In reality, the occupancy times may be much less, particularly for the public, because this equipment will move from site-to-site. In addition, these sites are generally located in remote areas and may have additional site access controls to further reduce potential doses. Therefore, this occupancy assumption is highly conservative.

6.2.3 External Dose Results

Occupancy values used in calculations are provided in Table 6-3. Using these occupancy times, 3 different dose rates were used to calculate potential doses. These dose rates are the maximum dose rate, the average dose rate, and the median dose rate. The maximum dose rates were identified for both occupational dose and public dose. For the occupational worker, all modeled grids were included. For a member of the public, only the boundary grids were included, as members of the public will be restricted from entering the work zone. The maximum dose rate was then multiplied by the number of occupancy hours in Table 6-3 to give the annual external dose. Dose rates and annual external dose results are given in Table 6-4.

To ensure the public dose remains below 100 mrem/yr for this occupancy scenario, the effective dose rate at the boundary needs to be less than 0.07 mrem/hr. The public dose model has a maximum effective dose rate of 0.05 mrem/hr at a distance of 50 feet from the transportation truck (when full). This meets the requirements for compliance with the public dose limits. Routine exposure rate surveys (using a Ludlum Model 19, or similar) will be performed along the restricted area boundary to document and verify radiation levels.

Table 6-3: Occupancy Times for Members of the Public and Occupational Workers

Individual Type	Hours/ Day	Months	Days	Hours
Occupational	8	9	270	2160
Public	8	6	180	1440

Table 6-4: Modeled External Dose Rates and Annual Doses - Workers and Members of the Public

Case	Type	Dose Rate (mrem/hr)	Annual Dose (mrem)	Dose Limit (mrem)	% of limit
Maximum	*Occupational*	4.54	9808	5,000	196%
	Public	0.05	74	100	74%
Average	*Occupational*	0.40	870	5,000	17%
	Public	0.02	22	100	22%
Median	*Occupational*	0.11	246	5,000	5%
	Public	0.01	14	100	14%

As stated in Section 6.1, maximum doses to employees and the public are unreasonable, considering that the length of time required to be in close proximity to maximum dose rates will not occur, as a result of

these operations. Average or median dose rates are significantly more likely scenarios. To ensure that public doses remain below the 100-mrem limit, Disa will utilize monitoring, access, and sampling procedures found in Appendix C.

6.3 Internal Dose

6.3.1 Modeling Approach

Internal doses were modeled using MILDOS. Four source terms were considered in the model. These four source terms and concentrations are given in Table 6-5. Other sources of particulate emission are considered negligible because downstream of the HPSA unit is considered wet processes. Dust control measures will also be used the waste rock pile and during crushing, but for modeling purposes these materials are considered dry. It is assumed that the uranium is in secular equilibrium with its decay progeny. In most cases, MILDOS default values for parameters are used. For example, particle size distributions, deposition velocities, wind rose patterns, and surface roughness default values were used. Radon release rates and outdoor equilibrium factors were calculated by MILDOS using the built-in Erosion Model for particulates. The model assumed no ingestion rate from vegetables, meat, or milk. Eight receptors were modeled at various locations around the sources. The occupancy factor was conservatively assumed to be 1 for outdoor occupancy for each receptor, i.e., the receptor is present at that location for 100% of the year. The maximum distance from source that a receptor was modeled is approximately 300 meters. The source and receptor arrangement are shown in Figure 6-3.

Table 6-5: Internal Dose Model Source Terms, Uranium Concentrations, and Particle Densities

Source Term	Concentration, mg U/kg	Particle Densities
Waste rock Pile	1500	2.3 g / cm^3
Reject Pile	500	2.3 g / cm^3
Crusher	1500	2.3 g / cm^3
HPSA Unit	7000	2.3 g / cm^3

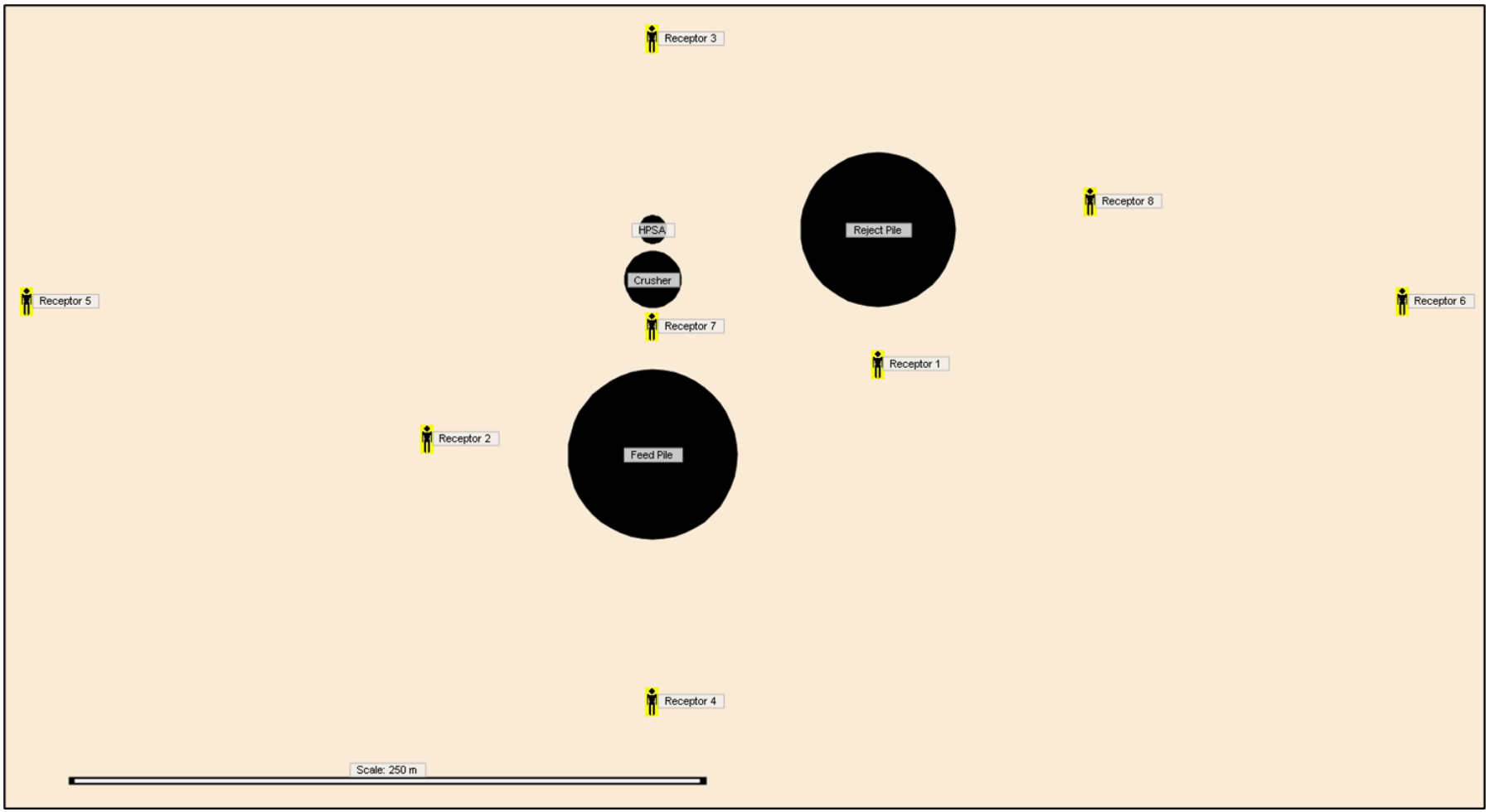
6.3.2 Internal Dose Results

Results for internal doses did not consider occupational or public doses explicitly. Receptors who would be located within a restricted area are representative of occupational doses, while the receptors outside of a potential restricted area would be representative of public doses. Results for each receptor are provided in Table 6-6. The maximum value of 22.3 mrem is attributed to Receptor 7, which is located in between the waste rock pile and the Crusher equipment. Receptor 1, located between the waste rock pile and reject pile, would receive a dose of 6.1 mrem. Results representative of potential public doses range from 0.4 to 2.4 mrem. These values suggest that internal doses will be negligible. Actual doses are likely to be less than those modeled due to the conservative occupancy factor use by MILDOS.

Table 6-6: Annual Internal Dose Results for each Modeled Receptor

Receptor	Total Annual Dose (mrem)
1	6.1
2	1.7
3	2.1
4	1.8
5	0.4
6	0.6
7	22.3
8	2.4

Figure 6-3: Source Term and Receptor Locations for MILDOS Internal Exposure Model.



6.4 Comparison of Dose from Waste Rock Material to Process Coarse

Simple external and internal dose modeling of the waste rock and clean coarse fraction were performed individually to investigate the potential benefit from dose reduction for materials that are present on these sites. The models are consistent with those included in the models above (size, volume, concentration). For the external dose, 6 receptors were modeled at 5 ft increments, started at 1 ft from the edge of the pile. For the internal doses, 4 receptors were modeled at distance of 254 feet (100 m) in the cardinal directions around each pile. The results of these models are provided in Table 6-7. From these results, it is clear there is a reduction in doses from onsite materials. The reduction in dose ranges from 59 to 72% with an average reduction in external dose of 67% and internal dose of 73%.

Table 6-7. Dose Reduction Comparison Between Waste Rock and Clean Coarse Fraction

	Receptor	Distance from Source (ft)	Waste Rock Dose, (mrem)	Clean Coarse Fraction Dose (mrem)	Reduction (%)
External	1	1	0.99	0.40	59
	2	5	0.46	0.15	68
	3	15	0.15	0.05	69
	4	25	0.07	0.02	70
	5	35	0.04	0.01	70
	6	45	0.02	0.01	66
Internal	1	254	3.08	0.83	73
	2	254	1.44	0.40	72
	3	254	1.94	0.52	73
	4	254	1.77	0.49	72

6.5 Summary

The external and internal doses were modeled using conservative assumptions and parameters. In general, these results represent conservative upper boundaries to potential doses. The external results indicate that expected occupational doses will remain below occupational dose limits, on average. However, the results also indicate there is a potential for workers to exceed their annual dose limit.

Based on the current external dose model and occupancy scenario, a member of the public will receive a dose of 74 mrem/yr if exposed to the maximum modelled dose rate. This scenario is unlikely and the average and median results show a comfortable margin of safety below public dose limits. At no point does any dose rate along the model boundary approach 2 mrem/hour. Routine exposure rate measurements and site access control will be used to ensure public doses remain ALARA.

Finally, it is clear from the dose reduction comparison that there is a great benefit, both to the environment and to humans, from this process. While there is a short-term risk incurred during the operation of this equipment, there is a permanent reduction of approximately 70% in potential dose.

SECTION 7.0 FINANCIAL ASSURANCE

Activities under the proposed license will involve handling and managing radioactive materials. However, Disa will not take possession of the radioactive materials for any project. Therefore, financial assurance will be based on the third-party cost to transport the isolated mineral fraction to a licensed uranium recovery facility or waste disposal facility and decontaminate all equipment to unrestricted release criteria. Costs will also include health physics and project management time per site. Untreated waste rock and clean coarse fraction materials will remain onsite.

Table 7-1 presents an estimate required to decommission and demobilize HPSA equipment from a site by a third party.

Table 7-1: Decommissioning and Demobilization Costs – Third Party

Item	Quantity	Unit	Rate	Total
Radiation Safety Officer	5	days	$1,400.00	$7,000.00
Radiation Tech (2)	10	man-days	$1,200.00	$12,000.00
Work Truck	8	days	$175.00	$1,400.00
Detection Instruments & Sources	1	Lump Sum	$3,975.00	$ 3,975.00
PPE, all Supplies and Materials	1	Lump Sum	$1,495.00	$1,495.00
Lab Fees	1	Estimate	$4,000.00	$4,000.00
Transportation to Licensed Facility	1	trip	$3,950.00	$3,950.00
Heavy Equipment w/Mob Demob	1	Lump Sum	$2,450.00	$2,450.00
Contingency (15%)				$5,440.50
Total				$41,710.50

Disa will maintain a rotating fund that will provide the Table 7-1 amount per site that is actively being remediated and will eliminate the financial assurance for all completed sites. Disa will determine that a project is complete when the following occur:

- Isolated mineral fraction materials are transported offsite for disposal or utilization as an alternate feed.
- Equipment within the restricted area is decontaminated and scanned for unrestricted release.
- Post-operational surveys of the work area are performed and confirm no releases have occurred.
- Equipment is mobilized offsite.

Documentation of project completion will be maintained by Disa and will be used to release project-specific financial assurance. Disa will determine the type of financial assurance mechanism it will use and will formalize the financial assurance arrangements at the time of license issuance. Disa's financial assurance mechanism will comply with 10 CFR 40.36(e).

SECTION 8.0 PROPOSED LICENSE CONDITIONS

Disa requests the following license conditions:

1. Authorized places of use:
    a. The licensee is authorized to use its HPSA technology on any mine site that has been inactive for 5 years or more.
    b. The licensee is authorized to use its HPSA technology on any site contaminated by mining operations, whether or not mining has occurred on that site.

2. Change, Test and Experiment License Condition
    a. The licensee may, without obtaining a license amendment pursuant to 10 CFR 40.44, and subject to conditions specified in (b) of this condition:
        i. Make changes in the facility as described in the license application (as updated);
        ii. Make changes in the procedures as described in the license application (as updated); and
        iii. Conduct tests or experiments not described in the license application (as updated).
    b. The licensee shall obtain a license amendment pursuant to 10 CFR 40.44 prior to implementing a proposed change, test, or experiment if the change, test, or experiment would:
        i. Result in more than a minimal increase in the frequency of occurrence of an accident previously evaluated in the license application (as updated);
        ii. Result in more than a minimal increase in the likelihood of occurrence of a malfunction of a facility structure, equipment, or monitoring system (SEMS) important to safety previously evaluated in the license application (as updated);
        iii. Result in more than a minimal increase in the consequences of an accident previously evaluated in the license application (as updated);
        iv. Result in more than a minimal increase in the consequences of a malfunction of a SEMS previously evaluated in the license application (as updated);
        v. Create a possibility for an accident of a different type than any previously evaluated in the license application (as updated);
        vi. Create a possibility for a malfunction of a SEMS with a different result than previously evaluated in the license application (as updated);
        vii. Result in a departure from the method of evaluation described in the license application (as updated) used in establishing the final safety evaluation report (FSER), environmental impact statement (EIS), environmental assessment (EA) or technical evaluation reports (TERs) or other analyses and evaluations for license amendments;
        viii. For purposes of this paragraph as applied to this license, SEMS means any SEMS that has been referenced in a staff SER, TER, EA, or EIS and supplements and amendments thereof.
    c. Additionally, the licensee must obtain a license amendment unless the change, test, or experiment is consistent with NRC's previous conclusions, or the basis of, or analysis leading to, the conclusions of actions, designs, or design configurations analyzed and

selected in the site or facility SER, TER, and EIS or EA. This would include all supplements and amendments, and TERs, EAs, EISs issued with amendments to this license.

d. The licensee's determinations concerning (b) and (c) of this condition, shall be made by a Safety and Environmental Review Panel (SERP). The SERP shall consist of a minimum of three individuals. One member of the SERP shall have expertise in management and shall be responsible for financial approval for changes; one member shall have expertise in operations and/or construction and shall have responsibility for implementing any operational changes; and one member shall be the radiation safety officer (RSO) or equivalent, with the responsibility of assuring changes conform to radiation safety and environmental requirements. Additional members may be included in the SERP, as appropriate, to address operational and technical aspects. Temporary members or permanent members, other than the three above-specified individuals, may be consultants.

e. The licensee shall maintain records of any changes made pursuant to this condition until license termination. These records shall include written safety and environmental evaluations made by the SERP that provide the basis for determining changes comply with (b) of this condition. The licensee shall furnish, in an annual report to the NRC, a description of such changes, tests, or experiments, including a summary of the safety and environmental evaluation of each. In addition, the licensee shall annually submit to the NRC changed pages, which shall include both a change indicator for the area changed, e.g., a bold line vertically drawn in the margin adjacent to the portion actually changed, and a page change identification (date of change or change number or both), to the operations plan and reclamation plan of the approved license application (as updated) to reflect changes made under this condition.

3. Financial Assurance. The licensee shall maintain an NRC-approved financial surety arrangement, consistent with 10 CFR 40.36, adequate to cover the estimated costs, if accomplished by a third party, for decommissioning and decontamination, which includes decontaminating HPSA equipment, transporting the isolated mineral fraction and decontamination residues to a licensed uranium recovery or disposal facility, and disposing of any decontamination or wastewater. This financial assurance will be, at a minimum, five times the amount needed to decommission and decontaminate one site.

4. The licensee shall ensure that written standard operating procedures (SOPs) exist that address: (1) all operational activities involving radioactive materials associated with licensed activities that are handled, processed, stored, or transported by employees; (2) radiation protection and environmental monitoring; and (3) emergency procedures for potential accident/unusual occurrences including significant equipment. The SOPs shall include appropriate radiation safety practices to be followed in accordance with 10 CFR Part 20. SOPs for operational activities shall enumerate pertinent radiation safety practices to be followed. A copy of the current written procedures shall be kept on every site where HPSA is used.

5. Reporting.
    a. The licensee shall submit a report every year on the anniversary of this license issuance that provides a summary of the following: 1) specific sites remediated, 2) quantities of source material generated at each site and total annual quantities generated, 3) summary of exposure and dose measurements for each site and documentation of any exceedances.
    b. The Licensee will notify, in writing, the NRC staff a minimum of 14 days prior mobilizing to a site for HSPA remediation.

6. Radiation Safety Officer. The Radiation Safety Officer will be appointed by the licensee's SERP. This person will meet the qualifications presented in the approved application or amendment. At the licensee's discretion, the licensee's SERP will appoint an Alternate Radiation Safety Officer. Replacements for either the Radiation Safety Officer or the Alternate Radiation Safety Officer will be approved by the SERP. For the first RSO appointment, Disa will utilize the services of a contract Certified Health Physicist (CHP) to approve the RSO appointment.

7. The Licensee will consult with State and/or local historic preservation officers or similar governing body before beginning construction related to, or the use of, a HPSA system at a site that has not been analyzed for cultural or historic resources in compliance with another regulatory program.

8. The Licensee will consult with Federal or State fish and wildlife agencies to identify potential endangered or threatened species before beginning construction related to, or the use of, a HPSA system at a site that has not been analyzed for endangered species in compliance with another regulatory program.

9. The Licensee is granted a phased approval to utilize its HPSA process. The first phase will consist of performing a project to treat a minimum of 7,500 tons of waste rock over a maximum of 90 days. During this initial project, Disa will collect samples for analysis to demonstrate that the technology produces a clean coarse fraction, and renders a site safer than before the project. Samples will be analyzed for Toxic Characteristic Leaching Procedure (TCLP) metals, natural uranium, natural thorium, radium-226, and radium-228. The Licensee will also assess doses due to radionuclides found in the isolated mineral product, the clean coarse fraction, and within process equipment.

    The Licensee's Safety and Environmental Review Panel (SERP) will review the analytical data collected and dose assessments produced during this project and provide its assessment regarding the safety of the HPSA process. Disa will submit this SERP report for review to the NRC staff. Provided that the SERP has confirmed the safety of the HPSA process, once the licensee submits this SERP report, the licensee will be granted the authority to utilize the full performance-based, multi-site authorization granted by this license.

SECTION 9.0 REFERENCES

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2. cmpip, 2022. High-Pressure Slurry Ablation (HPSA): An Emerging Liberation Technology. Canadian Mill Processing Innovation. https://cmpip.ca/post/high-pressure-slurry-ablation. Accessed June 2022.

3. Disa, 2022a. Results of Bench Scale Testing of October Reclamation Pile Waste Rock. Disa Technologies, Inc. 2022.

4. Disa, 2022b. Letter to Colorado Department of Public Health and Environment. Disa Technologies, Inc. February 7, 2022.

5. Grove Software, 2022. MicroShield Pro, Version 9.07. https://www.radiationsoftware.com/microshield. Grove Software, Lynchburg, VA. 2022

6. NRC, 2002. Regulatory Guide 8.31, Revision 1, Information Relevant to Ensuring that Occupational Radiation Exposures at Uranium Recovery Facilities will be As Low As Is Reasonably Achievable. May 2002.

7. NRC, 2018a. NUREG-1556, Volume 12, Revision 1, Consolidated Guidance About Materials Licenses: Program-Specific Guidance About Possession Licenses for Manufacturing and Distribution (NUREG-1556, Volume 12, Revision 1). U.S. Nuclear Regulatory Commission. May 2018.

8. NRC, 2018b. NUREG-1556, Volume 12, Appendix J: Guidance for Demonstrating that Individual Members of the Public Will Not Receive Doses Exceeding the Allowable Limits. U.S. Nuclear Regulatory Commission. May 2018.

APPENDIX A – QUALIFICATIONS OF RSO, ARSO, AND RST

Andrew Halverson

EDUCATION

University of Wyoming, Laramie, WY – 2017-2021, GPA: **3.953**,
Major: **Chemical Engineering**
Minor: **Process Control Engineering**

WORK EXPERIENCE

Disa, Casper, WY – *Process Engineer*
July 2020 – Present

- Conducted R&D for High Pressure Slurry Ablation process to assess applicability of the technology to new markets.
- Served as site Radiation Safety Officer under general license for Disa R&D
- Designed process flow diagrams and material balances for proposed pilot projects.
- Conducted market research and developed techno-economic models for pilot projects.
- Assisted in grant writing to secure additional funding for pre-revenue company.

Sinclair Oil Refinery, Sinclair, WY – *Process Engineering Intern*
May 2019 - August 2019

- Collected field data and developed process packages for installation of control valves to optimize refinery hydrogen system.
- Created PI Processbook page to map refinery hydrogen system for system optimization.
- Worked with refinery operations and Baker Hughes representatives to create two chemical injection guides for Sulfur Recovery System and Hydrocracker Complex

Genesis Alkali, Green River, WY – *ELDM Operator 1*
May 2018 - August 2018

- Gained familiarity with plant equipment while assisting with equipment shut down and startup.
- Collected and performed lab analyses of samples from manufacturing plant streams.

Summer Research Apprenticeship Program, University of WY — *Intern Research Assistant*
June 2016 - July 2016

- Conducted basic research on the optical properties of nanoparticles.
- Interpreted research findings and summarized data into reports including oral presentation.

SKILLS

Proficient at:

- Aspen HYSYS, PI System Explorer, Microsoft Office (Excel, Word, Power Point, Outlook), Matlab, PI Processbook, Autodesk Fusion 360, LabX Titration Lite autotitrator, LabView
- Radiation safety record keeping and radiation monitoring equipment operation

Ability to perform hands on work

- Equipment modification, equipment startups and shutdowns

Ability to work in groups

- Worked for startup company Disa in a team of six people to evaluate market opportunities and solve engineering and economic problems

Strong negotiation skills

- Negotiated product prices with vendors to procure free product samples for testing for a pre-revenue company

ACCOMPLISHMENTS

- Member Tau Beta Pi
- Recipient of the Wyoming Trustee's Scholarship (Full Ride Academic)

Certificate of Training

Awarded To

Andrew George Halverson

Recognizing completion of **5** days of specialized instruction in

Radiation Safety Officer Training with DOT Certification

January 14, 2022

Presented By

NV5 –Training Academy

9200 Corporate Boulevard, Suite 380 Rockville, MD 20850
https://training.nv5.com/training/-- 301-990-6006
ABIH Diplomates can claim this course for 40 hours in the IH CM Area
AAHP has awarded this course 40 Continuing Education Credits 2019-09-01-646

Alan Fellman, Ph.D., CHP

CHP, CSP

Clark Barton, CHP, CSP

NV5
TRAINING ACADEMY

Certificate of Training

This Certifies That

Andrew George Halverson

has been trained, tested and successfully completed specialized instruction in

DOT, NRC, & IATA Requirements for Shipping Radioactive Materials

January 14, 2022

Presented By: **Clark Barton, CHP, CSP, Instructor**

NV5- Training Academy
9200 Corporate Boulevard, Suite 380 Rockville, MD 20850
https://training.nv5.com/training/ -- 301-990-6006

Presented For: **Disa Technologies, Inc.**

Presented At: **Rockville, MD**

Clark Barton, CHP, CSP

Clark Barton, CHP, CSP

This certifies that the employee named on this certificate has been trained and tested in accordance with the training requirements of 49 CFR 172, Subpart H.

Employer's Signature

This certificate is valid for 24 months for ICAO/IATA and for three years for U.S. Department of Transportation and U.S. Nuclear Regulatory Commission or Agreement State Agencies.

APPENDIX B – SAMPLE TRAINING PROGRAM

Radiation Safety Training

2021 Radiation Protection Program Training

Reasons for Radiation Safety Training

Required by NRC regulations and guidance

- NMAC 20.3.10.1002 (*Instruction to Workers*)
- NRC Regulatory Guide 8.31

Required by Service Provider's License

- Authorized users (AUs) and radiation workers must have adequate training and experience to use, possess, or provide services involving licensed materials.

Necessary to ensure

- Worker health and safety
- Compliance with regulatory dose limits and ALARA Policy

Worker's rights and responsibilities

- All workers have both the right and responsibility to understand, identify, and limit exposures to radiological hazards

Radiation Regulations

Regulatory Jurisdiction

- Colorado is an "**Agreement State**" with the authority to regulate certain uses of radioactive materials within the State.
- Radiation Protection is codified in Title 6, Code of Colorado Regulations 1007-1 (6 CCR 1007-1), Parts 1 through 24. Applicable Regulations include::
  - Part 3 - LICENSING OF RADIOACTIVE MATERIAL
  - Part 4 - STANDARDS FOR PROTECTION AGAINST RADIATION
  - Part 10 - NOTICES, INSTRUCTIONS, AND REPORTS TO WORKERS: INSPECTIONS

Licensed Radioactive Materials

Licensed radioactive materials that ERG possesses include:

- **Th-230** electroplated check sources.

Licensed materials may be encountered at clients' sites. ERG will never take possession of these materials.

- Licensed materials encountered at temporary worksites are subject to client's license, procedures, and applicable regulations (NM RCB, NRC, etc).
- ERG has Standard Operating Procedures to ensure safety while working with or handling licensed materials. (SOP RML.103 – Guidelines for Handling Radioactive Material)

Worker Rights and Responsibilities

- Workers shall observe applicable regulations and license conditions for protection from exposures to radiation or radioactive material.
- Promptly report to the RSO, Project Manager and/or AU any condition which may:
  - Violate applicable regulations or license conditions.
  - Represent an unusual occurrence or malfunction that could result in unnecessary exposure to radiation and/or radioactive material.
- Where radiological monitoring is required by the license, RSO, or RWP, workers may request a report of estimated radiation exposure and/or dose.

6 CCR 1007-1 Part 10 Notices, Instructions And Reports To Workers: Inspections

Colorado Department of Public Health and Environment

Colorado Department of Public Health and Environment
Hazardous Materials and Waste Management Division
Radiation management program

Notice to employees

Standards for protection against radiation (Part 4); Notices, instructions and reports to workers: inspections (Part 10); employee protection

To report radiation safety concerns or violations by your employer

Telephone:
303-692-3300 (daytime)
303-877-9757 (after hours)

Hazardous Materials and Waste Management Division Colorado Department of Public Health and Environment

Within Colorado, the Radiation Management Program of the Hazardous Materials and Waste Management Division (the Division) is the regulatory agency responsible for licensing and inspecting the use of radioactive materials and registering and inspecting radiation producing machines.

Hazardous Materials and Waste Management Division's responsibilities

The Division's primary responsibility is to ensure that workers and the public are protected from unnecessary or excessive exposure to radiation. The Division does this by establishing requirements in the State of Colorado Rules and Regulations Pertaining to Radiation Control, 6 Code of Colorado Regulations (CCR) 1007-1 (the Regulations).

Employer responsibilities

Any individual conducting activities licensed or registered by the Colorado Department of Public Health and Environment (the Department), Hazardous Materials and Waste Management Division, must comply with the Department's requirements. If a violation of the Department's requirements occurs, the license or registration can be modified, suspended, or revoked, and/or the licensee or registrant can be fined.

Your employer must post or make available Department radiation regulations and must post Department Notices of Violation involving radiological working conditions.

Employee responsibility

For your own protection and the protection of your co-workers, you should know how Department requirements relate to your work and should obey them. If you observe violations of the requirements, you should report them.

Reporting violations

If you believe that violations of the Department rules or of the terms of the license have occurred, you should report them immediately to your supervisor. If you believe that adequate corrective action is not being taken, you may report this to a Department inspector or to the Division.

Working in a radiation area

If you work with or in the vicinity of radioactive materials or radiation producing machines, the amount of radiation exposure you may legally receive is limited by the Regulations. The limits on your exposure, as well as limits for an embryo/fetus, are contained in Part 4 of the Regulations. While those are the maximum allowable limits, your employer should also keep radiation exposure as far below those limits as is "reasonably achievable".

Obtaining a record of worker radiation exposure

If the Regulations require that your radiation exposure be monitored, your employer is required to advise you annually of your dose. In addition, if you terminate employment with the licensee or registrant, you may request that your employer provide, at termination, a report of your radiation exposure during the current year.

Identifying violations of Department requirements

The Department conducts regular inspections at licensed and registered facilities to assure compliance with Department requirements. In addition, licensees and registrants are required to perform audits, surveys and/or measurements to assure compliance.

Contacting a Department inspector

Your employer may not prevent you from talking with a Department inspector and you may talk privately with an inspector and request that your identity remain confidential.

Requesting an inspection

If you believe that your employer has not corrected violations involving radiological working conditions, you may request an inspection. Your request should be addressed to the Hazardous Materials and Waste Management Division, Colorado Department of Public Health and Environment, and must describe the alleged violation in detail. You or your representative must sign the request.

Contacting the Department

Call the Division. Department staff would like to talk to you if you are worried about radiation safety or other aspects of licensed or registered activities.

Can I be fired for raising a safety issue?

Federal law prohibits an employer from firing or otherwise discriminating against you for bringing safety concerns regarding radioactive material to the attention of your employer or the Department. You may not be fired or discriminated against because you*:

- ask the Department to enforce its rules against your employer;
- refuse to engage in activities which violate Department requirements;
- provide information or are about to provide information to the Department or your employer about violations of requirements or safety concerns;
- are about to ask for, or testify, help or take part in, a Department, Congressional, or any Federal or State proceedings.

*NOTE: Federal Law Provisions do not apply to workers using only radiation producing machines (x-ray machines).

What forms of discrimination are prohibited?

It is unlawful for an employer to fire you or to discriminate against you with respect to pay, benefits, or working conditions because you help the Department or raise a safety issue.

How am I protected from discrimination?

If you believe that you have been discriminated against for bringing violations or safety concerns to the Department or your employer, you may file a compliant with the U.S. Department of Labor pursuant to Section 211 of the Energy Reorganization Act of 1974 (42 U.S.C. 5851). To do so you may directly contact the Occupational Safety and Health Administration (OSHA) Regional Office to receive your complaint. Your complaint must describe the firing or discrimination and must be filed within 180 days of the occurrence.

Send complaints to:

Department of Labor/OSHA
1999 Broadway, Suite 1690
P. O. Box 46550
Denver, Colorado 80201-6550

or contact OSHA office by telephone at (720) 264-6550 or by fax at (720) 264-6585.

What can the Department of Labor do?

The Department of Labor (DOL) will notify the employer that a complaint has been filed and will investigate the case.

If the DOL finds that your employer has unlawfully discriminated against you, it may order that you be reinstated, receive back pay, or be compensated for any injury suffered as a result of the discrimination.

What can the Radiation Management Program do?

If DOL or the Division finds that unlawful discrimination has occurred, the Division my issue a Notice of Violation to your employer, impose a fine, or suspend, modify or revoke your employer's license or registration.

Occupational Hazards

Physical and Radiological Safety

Occupational Hazards

In **MOST** cases, physical safety hazards pose the greatest concern, especially while on site. Common examples include:

- Vehicles / heavy operating equipment
- Rugged terrain and slippery or uneven/loose surfaces (potential for slips, trips, falls)

Potential Radiological Exposure Hazards

- Short-lived radon decay products in air (e.g., emanation of radon gas from the radioactive decay of Ra-226 in mill tailings)
- Direct (external) gamma radiation
- Long-lived radionuclides in airborne particulates (e.g., fugitive dust)
- Accidental ingestion of radionuclides (due to contaminated personnel or equipment)

Potential to spread contamination.

Occupational Hazards

- Occupational hazards while in office are primarily physical safety hazards.
- Virtually no radiological risk from licensed materials in office (Th-230)
- Other exempt and/or generally licensed sources are also low-risk of external exposure.
- Will still maintain ALARA principles and ensure security of all radiological sources not in-use.

Radiation BASICS

Definitions and Concepts for Radiation Protection

What is Radiation?

- Radiation is a part of our natural world
- It is not a human invention, and has been part of the Earth's environment since it's creation
- Without radiation, life as we know it would not be possible
- We live in a "sea" of radiation from natural sources (sun, stars, soils/rocks, food, water)
- The human body also emits radiation
- Fundamentally, radiation is the release of excess energy

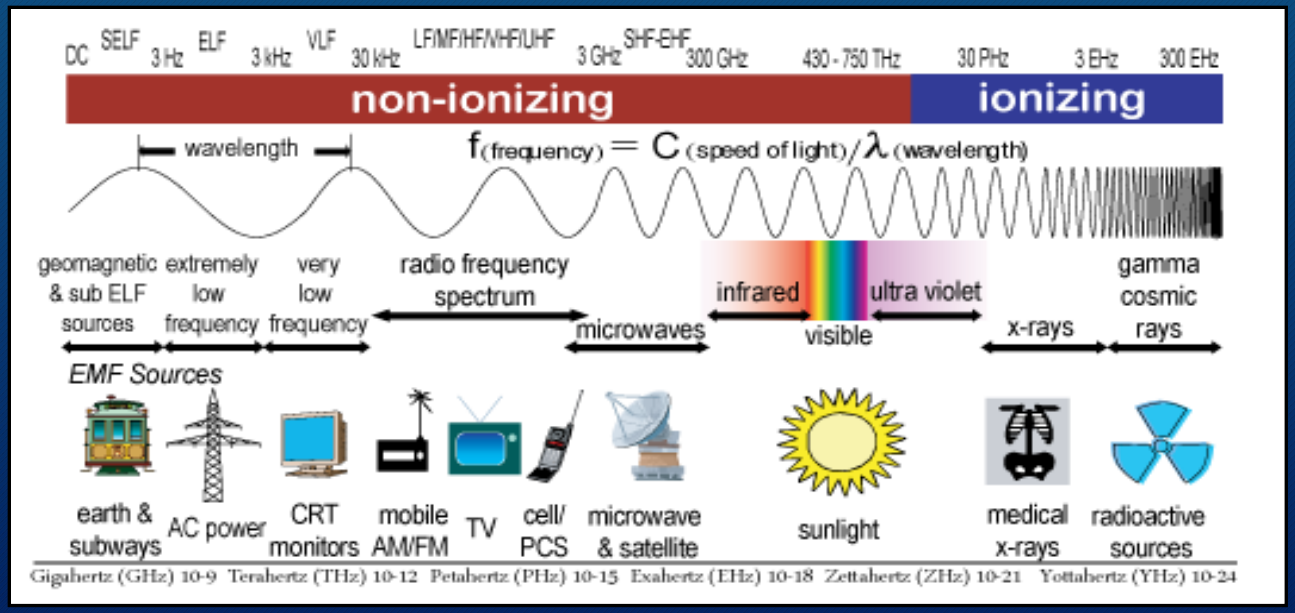
Types of Radiation

Ionizing

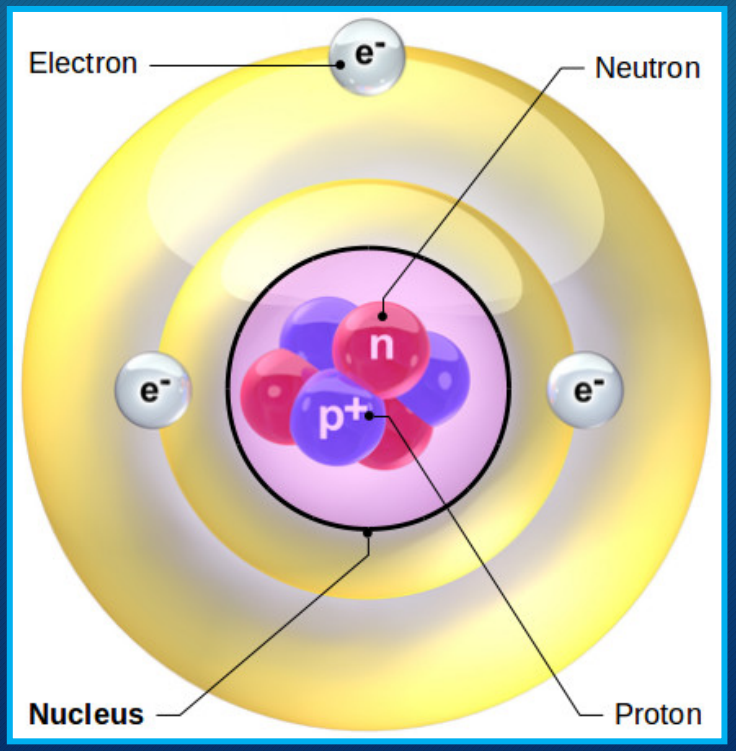
- High energy, can remove electrons from atoms
- X-rays, gamma rays, alpha and beta particles
- Can damage DNA in living organisms

Non-Ionizing

- Lower energy (longer wavelengths)
- Sunlight, microwaves, radio waves
- Can damage cells by heating



Atom – Basic Building Block of all Matter



- **Nucleus**
  - **Protons**
    - Positive electrical charge (+1)
    - Number determines element
  - **Neutrons**
    - No charge
- **Electrons**
  - Negative electrical charge (-1)

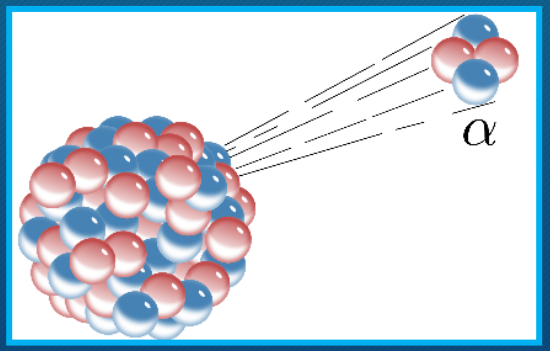
Unstable atoms have excess energy that is released by "decay" into other types of atoms and emission of ionizing radiation

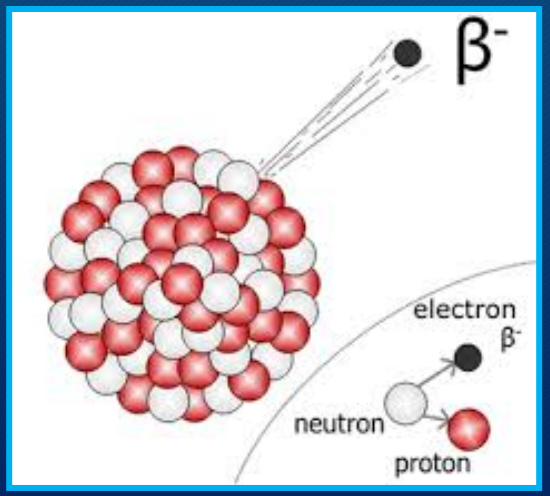
General Radioactive Emissions:

- Alpha particles
- Beta particles
- Gamma rays

Alpha and Beta Particles

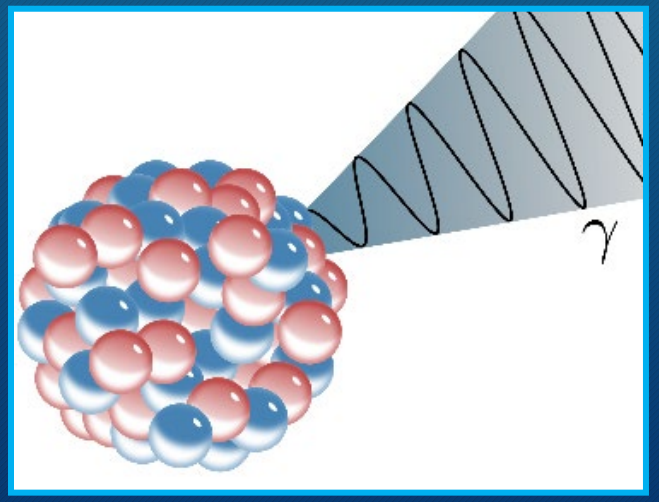
- **Alpha particles**
  - Originates in nucleus
  - Large & heavy particle; charge of +2
  - Densely ionizing when traveling through matter (results in rapid loss of kinetic energy)
  - Will not penetrate a piece of paper or the layer of dead skin cells
- **Beta particles**
  - Identical to an electron, but originates in nucleus
  - Charge of -1; very small particle
  - Can penetrate up to ½ inch in tissue



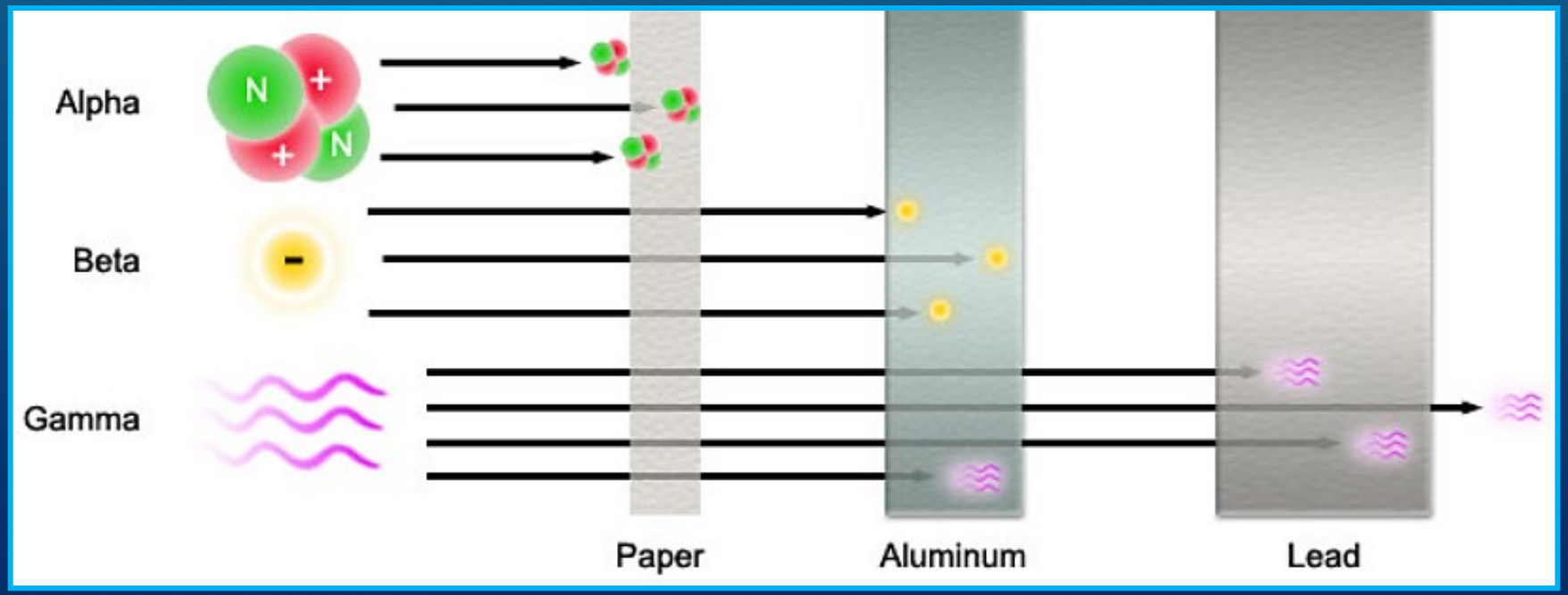


Gamma radiation and x-rays

- Photons with no mass or charge – like visible light, but with greater kinetic energy
- Gammas originate in nucleus, x-rays originate from orbital electron shells
- Can travel long distances in air and penetrate through matter
- Can be partially shielded by heavy/dense materials such as lead, the cab of a vehicle, or heavy operating equipment



Penetrability of Ionizing Radiation



What is Radioactive Material?

- Any material that emits ionizing radiation
- Can be natural (e.g. soil, rocks, unprocessed uranium ore) or made by humans (e.g. byproduct wastes from uranium mills)
- There are regulatory classifications for different types of radioactive materials (e.g. source material, byproduct material)
- Smoke detectors are an example of a device that provides a beneficial use for radioactive material
- Some sources of radiation do not contain radioactive materials (e.g. X-ray machines)

Radiation Measurement

Concepts, Quantities and Units

Radiation Quantities and Units

Radiation exposure - amount of gamma radiation or X-rays in air – can be directly measured with instruments.

- **roentgen (R).**
- **micro-roentgen (µR)**: most common unit of measure for many sites.

Radiation dose - cannot be measured directly – a calculated quantity based on measurements of radiation exposure or amount of radioactivity in the body.

- **rem** ("roentgen equivalent man").
- **milli-rem** (mrem): most common unit of measure for many sites.
- Exposure to 1 mR in air will result in approximately 1 mrad of absorbed dose 1 cm deep in tissue (or 0.7 mrem of whole-body "effective" dose equivalent).

Radioactivity

Radioactivity is the rate of radioactive decay

- Faster decay rate = shorter half-life = higher radioactivity
- Slower decay rate = longer half-life = lower radioactivity

Curie (Ci) – fundamental unit of radioactivity in U.S.

- 1 Curie = 37 billion decays per second

  Very large amount of radioactivity, equivalent to 1 gram of pure radium-226

- picoCurie (pCi) = one trillionth (10^{-12}) of a Curie

  Very small amount of radioactivity - most commonly used unit of measure for radioactivity levels found in environmental media (e.g. soil, air, water)

Radiation Detection

To measure or detect radiation, we employ different instruments. Some examples:

- Gamma rays/x-rays - Scintillators (NaI(Tl)), Ionization Chambers, Semiconductors (HPGe)
- Alpha - Scintillators (ZnS(Ag)), Proportional counters, Liquid scintillation
- Beta - Scintillators (Plastic), Geiger-Mueller, Gas proportional, Liquid scintillation
- Air particulates - Low/Hi-Volume Air samplers, Breathing Zone samplers
- Dose - OSL/TLD badges, Ionization chambers, specially-calibrated detectors
- Radon - Track-etch detectors, real-time air sampling (Durridge RAD7), radon-flux measurements

Radiation measurement methods and instrument operation described in SOPs, RWPs, work plans, etc.

Radiation Dose to People

Sources, Levels, and Radiation Protection Limits

Common Sources of Radiation Dose

Natural Background Radiation

- Radon (inhalation)
- Internal radiation (from intakes via food, water, etc.)
- Cosmic radiation from outer space
- Terrestrial radiation from soils and rocks in Earth's crust

Medical Radiation

- Diagnostic (x-rays, isotope tracers, etc.)
- Therapy (high doses of radiation to kill cancer cells)

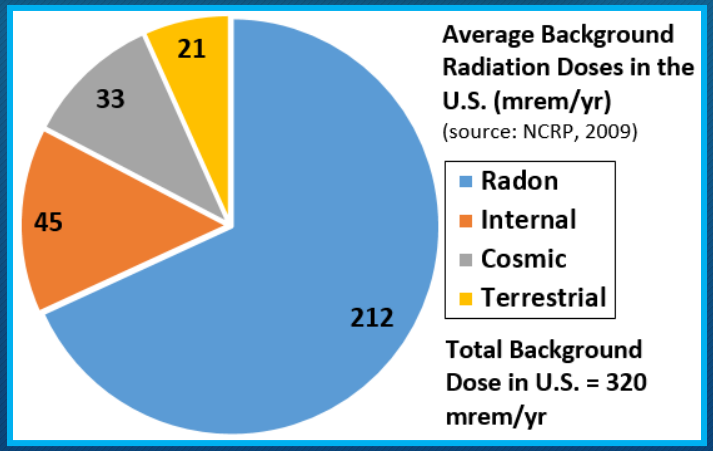
Occupational Radiation

- Uranium mine/mill workers, nuclear power plant workers, medical personnel, lab workers, etc.

Average Background Doses

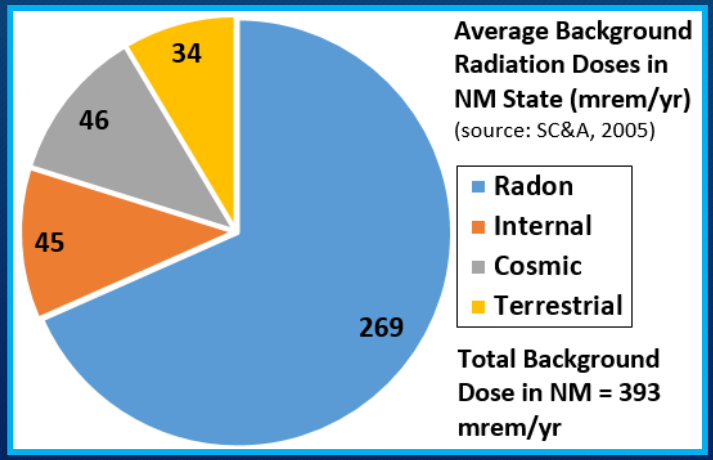
U.S. Averages

- Radon (212 mrem/yr)
- Internal (45 mrem/yr)
- Cosmic (33 mrem/yr)
- Terrestrial (21 mrem/yr)
- **Total ≈ 320 mrem/yr**



NM State Averages

- Radon (269 mrem/yr)
- Internal (45 mrem/yr)
- Cosmic (46 mrem/yr)
- Terrestrial (34 mrem/yr)
- **Total ≈ 393 mrem/yr**



Occupational Dose Limits

- A **Radiation Worker** is defined by the NRC as any employee who may receive an annual dose greater than 100 mrem from working at a licensed facility.
- Radiation workers subject to radiation training requirements.
- Dose limits for Radiation Workers:
  - **Total dose limit = 5,000 mrem/yr**

Public Dose Limits

Dose Limits for Members of the Public from Licensed Facilities

- 100 mrem/yr from facility operations (includes radon)
- 25 mrem/yr for license termination and unrestricted future use (excludes radon)

Public Dose Limits for Other Sources of Radiation

- For uranium mines (not mills), cleanup standards for mine reclamation and unrestricted public use are set by the State of NM (MMD and NMED).
- EPA uses a maximum lifetime "Risk" limit of 10^{-4} (1 chance in 10,000) of developing cancer to regulate cleanup levels for Superfund Sites under CERCLA.

BIOLOGICAL EFFECTS

Risks of exposure to ionizing radiation

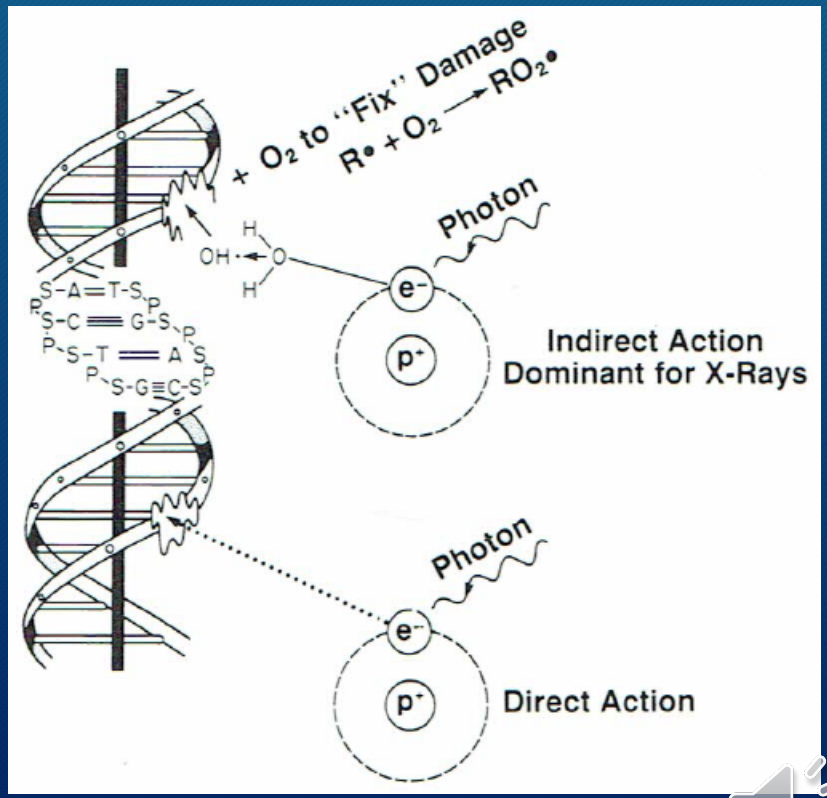
Biological Effects of Ionizing Radiation

Possible outcomes from radiation damage to DNA in living cells:

1. Interaction produces no damage to DNA, no effect on cell
2. DNA damage properly repaired, followed by normal cell function
3. Cell dies without consequence
4. Improper DNA repair occurs and abnormal cell function results

External radiation damage:

- **Direct** ionization/damage to DNA
- **Indirect** chemical damage from production of free radicals



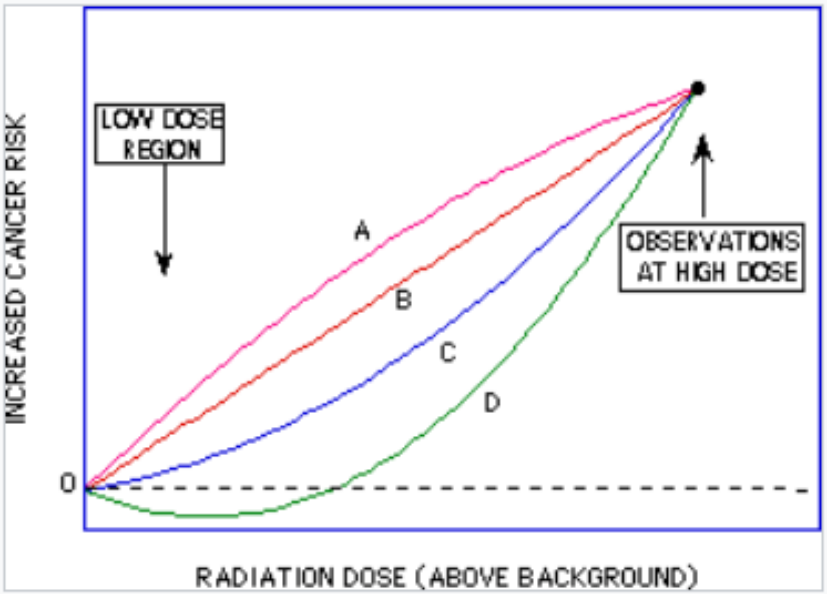
Biological Effects of Ionizing Radiation

Biological repair of radiation damage:

- Humans constantly bombarded by environmental radiation.
- Empirical evidence that capacity for repair increases with chronic low-level exposure (called “adaptive response”)
- Results in a threshold level of dose before cancer risk increases

Regulatory dose limits based on linear no-threshold (LNT) model:

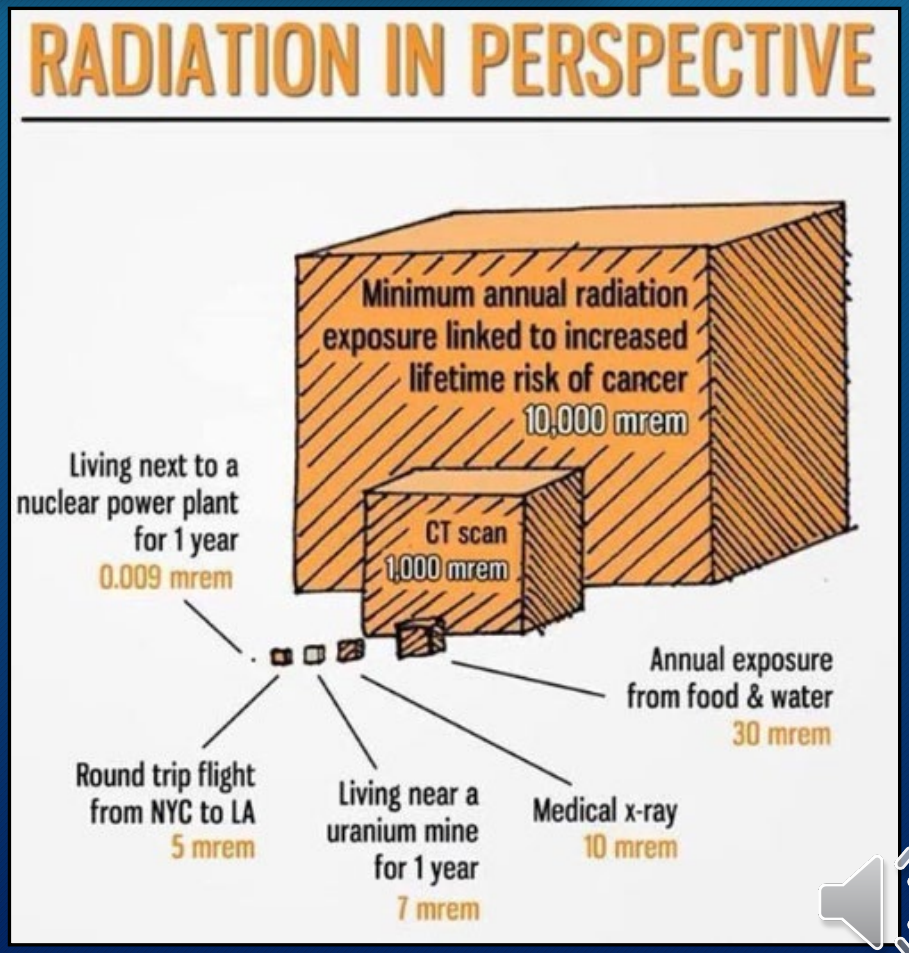
- Considered conservative for regulatory purposes



Alternative assumptions for the extrapolation of the cancer risk vs. radiation dose to low-dose levels, given a known risk at a high dose:
(A) supra-linearity, **(B)** linear
(C) linear-quadratic, **(D)** hormesis

How much Radiation is a concern for Human Health?

- Radiation dose from ionizing radiation described in units of “milli-rem” (mrem)
- **10,000 mrem** = lowest dose known to increase cancer risk
- **5,000 mrem** = annual regulatory limit for workers at licensed radiation facilities
- **320 mrem** = average annual dose to the U.S. population from natural background radiation
- **< 100 mrem** = expected occupational dose



Risk in Perspective

- Risk for workers subject to the regulatory dose limit of 5,000 mrem/yr:
  - A study of workers at uranium mills showed no difference in cancer rate from that of the general population
  - No increased cancer rate in studies of nuclear power plant workers
- No demonstrated health effects at high natural background levels:
  - Studies of populations in areas with much higher than normal background levels found no increase in cancer incidence.
  - States in the U.S. with higher background levels tend to have lower cancer rates than States with low background radiation levels

Risk from Radon

- Radon itself (a gas) does not present a hazard; it is the decay products of radon (progeny) that causes the dose to the lung and the risk of lung cancer.
- **Indoor radon** is a major contributor to background radiation dose because it can build up in homes, offices and other enclosed structures.
- **Outdoor radon** is often diluted through turbulent mixing and dispersal in the atmosphere and is generally not as significant to total radiation dose versus indoor radon.

Radiation Safety Principles and Radiation Protection Program

Basic Principles of Radiation Protection

- **Justification - no exposure allowed unless justified by the benefit(s)**
  - Some occupational dose incurred is justified because the work being done has a benefit (reduced potential for long-term risks to human health and the environment)
- **Optimization -As Low As *Reasonably* Achievable (ALARA)**
  - Doses should be kept as low as reasonably achievable given the work that must be done, and with economic, technological and social factors being taken into account.
- **Limitation - Occupational dose limit of 5,000 mrem/yr for all radiation workers**

Potential Exposure Pathways

- Direct (external) radiation
- Inhalation of dust or aerosols containing radionuclides
- Inhalation of radon decay products
- Ingestion of contaminated materials such as soil or water
- Injection or entry into the body through open cuts or abrasions on skin

Protection Principles for Direct (external) Radiation Exposure

- Minimize the **TIME** spent in areas with elevated exposure rates
- Maximize the **DISTANCE** from these areas
- Use **SHIELDING** when practical
  - Heavy equipment reduces doses by about a factor of two

Protection Principles for Inhalation Exposures

Source control:

- Use wet processes and/or dust suppression methods where possible

Exposure control:

- Limit work on windy days; work upwind of Sources
- Monitor air to determine exposure levels and develop mitigation controls if needed.

Protection from Accidental Ingestion

Primary cause of ingestion of radionuclides is carelessness and not following radiation safety work rules.

- No eating, drinking or tobacco use in Restricted Areas
- Check for contamination before leaving Restricted Areas or site
- Wash hands before eating, drinking, or tobacco use.

Protection Principles for Intake Through Skin

Primary route of intake through the skin is absorption through fresh, open cuts, abrasions, etc.

- Any open cuts or breaks in the skin should be covered before working anywhere onsite.
- Use of proper PPE (long-sleeved coveralls, work gloves, etc.) will reduce the risk of injury to skin.

Expected Occupational Dose

Radiological Environment

For in office activities, radiological exposures are expected to be very low. Exposure sources include external, inhalation, and ingestion related to inventory of calibration and check sources.

Sources are low-activity.

Sources are secured in locked safe when not in use.

Proper handling and storage of sources will keep exposures ALARA.

Potential Exposure Sources

In office:

- Calibration and check sources

On site:

- Depends on site/project
- Environmental media and contamination, tailings, source material, ore, waste rock, client source inventory, radiation producing machines, elevated radon levels

Conclusions on Expected Occupational Doses

- Regulatory threshold that requires occupational radiation dose monitoring = 500 mrem/yr.
- Annual doses to workers expected to be much less than 100 mrem, so routine occupational monitoring is not warranted.
- For non-routine activities conducted under RWPs, occupational dose monitoring may be required by RSO or project manager.

ALARA Policy

- Radiation doses shall be kept **As Low As Reasonably Achievable (ALARA)** below the established limits, taking into account the work that must be accomplished.
- This means taking all **practical** steps to reduce radiation exposures.
- **ERG policy is that radiation doses to all personnel will be kept ALARA.**
- All employees and contractors must acknowledge the policy and agree to abide by it.

Radiation Protection Program Elements

- Radiation Worker Training
- Radiation Safety Work Rules
- Contamination surveys (personnel, equipment release surveys)
- Radiation Work Permits (RWP)
- Personal Dosimetry
- Urine Bioassay– at RSO discretion (under RWP)
- Occupational Air Monitoring – at RSO discretion (under RWP)
- Annual dose tracking

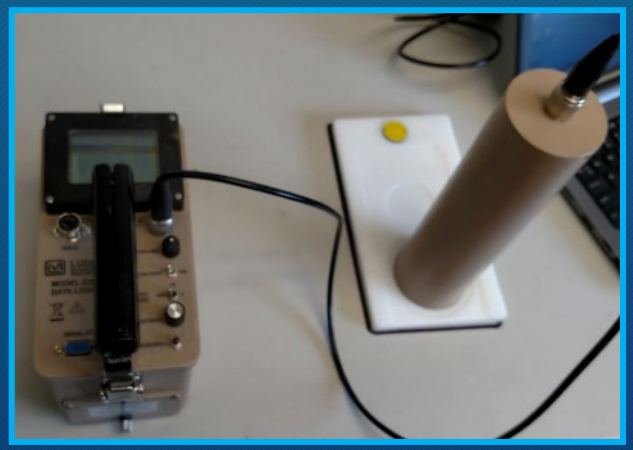
Radiation Work Permits (RWP)

- Planning document that specifies requirements for radiation protection when performing non-routine tasks.
- For when potential for elevated radiation exposure risks.
- Issued at discretion of RSO when standard operating procedures do not adequately cover the work in question
- Developed and issued by the RSO.
- Provisions may require specific training and special monitoring at the discretion of the RSO.

RWP Work Rules

- All RWP workers must be trained in radiation safety and RWP provisions.
- Tobacco use, eating and drinking not allowed in RWP work areas.
- RWP workers will attend health and safety meetings as prescribed by project work plans.
- Contamination surveys of hands, feet, and clothes before leaving RWP work areas.
- Wash hands before eating, drinking, or using tobacco products.
- RWP may require additional work rules.

Contamination Surveys



Personnel Exit Surveys

Where required by work plans, regulations, RWPs, etc.

- All workers must scan out prior to leaving a Restricted, Contamination, or RWP areas
- Intended to prevent offsite transport of contamination on personnel
- A trained radiation safety technician (RST) will ensure personnel exit scan results are documented and filed for review by the RSO, project manager, and/or regulators.

Equipment Release Surveys

- Where required, all equipment/tools, vehicles, heavy operating machinery, etc. will be surveyed prior to release from Restricted, Contamination, or RWP Areas
- Must meet specific limits for release
- The RST will perform these surveys along with swipe tests for removable (loose) contamination, as required.

ERG Radiation Protection Staff

- **Radiation Safety Officer (RSO)** — Bryan Erdmann

  Mobile: 425-737-1746

  Email: bryanerdmann@ergoffice.com

- **Operations Manager** — Chuck Farr (ERG)

  Mobile: 505-604-6290

  Email: chuckfarr@ergoffice.com

Contact any of the above personnel with questions or concerns about radiation safety, related procedures, etc.

Radiation Safety Officer Functions

- Oversees the Radiation Protection Program (RPP)
  - Directs RPP elements and advises ERG Staff on radiation protection issues
  - Provides guidance/oversight as needed for AUs, RSTs, and site workers
- Reviews and evaluates RPP and license-related data, including:
  - Contamination surveys
  - Radiation Work Permits (RWP)
  - Dosimetry and bioassay results
  - Environmental Monitoring results
- Performs radiation dose assessments
- Develops/performs radiation protection training
- Supports AUs and project managers as needed to ensure compliance with Radioactive Materials License requirements and applicable regulations

Questions?

Email RSO with any questions: bryanerdmann@ergoffice.com

Phone/Teams calls available as necessary to ask questions about any procedures or radiation protection program provisions.

Upon completion of Radiation Safety Training exam, turn in to RSO (in-person or electronically) and ask any questions. Wrong exam answers will be discussed, and any deficiencies corrected.

APPENDIX C – STANDARD OPERATING PROCEDURES

Disa Technologies, Inc.

SOP-01 Rev. 0

ALARA

Standard Operating Procedure

Approvals

Chief Operating Officer	*Date*
Radiation Safety Officer	*Date*

REVISION LOG		
Revision Number	**Description of Changes**	**Pages Affected**
0	**Initial Release**	**All**

1. PURPOSE

The purpose of this procedure is to define Disa, Inc.'s (Disa's) program for reducing exposures to ionizing radiation and radioactive material(s) to levels that are As Low As Reasonably Achievable (ALARA). Disa's policy is to maintain radiation exposure to Disa personnel and the general public to levels that are ALARA from the maximum limits specified in 10 CFR Part 20. Disa shall implement its ALARA policy by training personnel for radiation safety, implementing Standard Operating Procedures (SOPs), using appropriate control measures, Radiation Work Permits (RWPs), good housekeeping practices, administrative control limits, and radiation protection equipment as needed.

2. RESPONSIBILITIES

2.1 Radiation Safety Officer (RSO), Assistant Radiation Safety Officer (ARSO) –

The RSO and ARSO responsibilities include:

- All appropriate project/site personnel are properly trained on ALARA principles.
- Radiological surveys are performed to provide current information on the radiological environment(s) to which personnel are potentially exposed, as needed.
- Areas that contain licensed material are properly posted.
- Appropriate personal protective equipment (PPE), dosimetry and radiological instrumentation, are prescribed, as needed.
- Radiation Work Permits (RWPs) are used for non-routine operations that has the potential to result in a significant radiological dose based on the radionuclide quantity, form, and work to be performed.
- Stop work authority is maintained and encouraged, as necessary, to ensure ALARA.

2.2 Field Services Manager (FSM) –

The FSM responsibilities include:

- Support the RSO, ARSO, AU, and ALARA program.
- Inform the RSO of any changes to site procedures or schedule that could affect radiation protection.

- Ensure personnel, resources, and support equipment necessary to ensure ALARA are available for project personnel by working with RSO and AU.
- Ensure that stop work authority is maintained and encouraged, as necessary, to ensure ALARA.

2.3 Radiation Safety Technician (RST) –

The RST responsibilities include:

- Report to the RSO on all radiological matters. Where appropriate, report to the onsite management for support on implementation of the ALARA program.
- Perform radiological surveys to provide current information on the radiological environments(s) to which personnel are potentially exposed, as needed.
- Manage onsite PPE, dosimetry, and radiological instrumentation, as needed.
- Ensure proper recordkeeping, instrument calibrations, and maintenance.
- Post areas that contain licensed material.
- Ensure that stop work authority is maintained and encourage as necessary to ensure ALARA.

2.4 Authorized Users (AU) –

AU responsibilities include:

- Comply with the Radiation Protection Plan (RPP) and the Standard Operating Procedures (SOP).
- Attend training and briefings on radiation protection and RWPs.
- Comply with all notices, postings, procedures, and instructions from radiation safety staff.
- Properly use and wear all required PPE.
- Follow basic ALARA principles including time, distance, shielding, and contamination control.
- Obey "stop work" and "evacuate" instructions issued by RSO, ARSO, another AU, or FSM.
- Wear and use monitoring devices as required by site procedures and instructions, postings, or the RSO, ARSO, or RST.

- Plan work ahead of performing work. Attempt to minimize exposures, as necessary.
- Leave Radiation Areas or Airborne Radioactivity Areas when not actively working. Use staging or "wait areas", when designated.
- DO NOT eat, drink, or smoke in restricted areas. One-time use water bottles may be used to stay hydrated.
- Perform a personnel scan for contamination when leaving any Restricted Area.
- Report known/potential radiologically unsafe or noncompliance situations to the RSO or ARSO.
- Report prior or concurrent occupational radiation exposures to the RSO.
- Maintain good housekeeping practices to minimize the spread of radiological contamination.
- Exercise stop-work authority and discuss immediately with RSO, ARSO, or RST any circumstance or condition that you believe is contrary the principles of ALARA.

3. PROCEDURE

- Prepare and execute Work Plans, SOPs, and RWPs with consideration for the ALARA concept.
- Establish radiological controls and monitoring requirements in Work Plans, SOPs, and RWPs.
- Make available sufficient PPE, dosimetry, and radiological instrumentation to support the ALARA program.
- Develop and maintain a personnel radiation exposure monitoring program.
- Senior Disa management shall maintain a formal policy and commitment to ALARA. This policy will be attached to the RPP.

4. REFERENCES

4.1 Radiation Protection Program (RPP) Manual

Disa Technologies, Inc.

SOP-02 Rev. 0

Operational Checkout of Single-Channel Detector with Meter

Standard Operating Procedure

Approvals

Chief Operating Officer	*Date*
Radiation Safety Officer	*Date*

REVISION LOG		
Revision Number	**Description of Changes**	**Pages Affected**
0	**Initial Release**	**All**

1. PURPOSE

To provide a method for the operational checkout, or "function check", of a single-channel meter and detector pair to ensure proper working condition of the instruments.

2. DISCUSSION

A radiological survey detector (detector) is paired with a compatible radiological survey meter (meter) to measure radiation in an integrated scaler count and/or count rate modes. This standard operating procedure (SOP) is specific to single-channel detectors compatible for use with a meter. In some cases, the detector and meter may be contained in a single housing. For this SOP, the detector and meter combination will be referred to as the detector only.

During the operational check-out process (function check), the detector is also inspected for any physical damage that might affect functionality, such as a cracked housing. Calibration of any survey detector is required prior to initial use, at least annually, and after any scheduled or unscheduled maintenance or repair that may affect instrument operation. Initial quality control (QC) source counts are made to established acceptable, baseline, instrument operating ranges (control limits). The detector response is compared against the control limits daily to identify if the instrument is working properly and consistently.

3. PROCEDURE

3.1 Equipment

- Radiological survey detector –

  Ludlum Model 19, Ludlum Model 43-5, Ludlum Model 44-9, Ludlum Model 44-10 detector, Ludlum Model 44-20 detector, or similar.
- Calibrated meter –

  Ludlum Model 12, Ludlum Model 2221, Ludlum Model 2241, or similar.
- Radiological check sources –
  - For typical function check of an alpha detector, use a thorium-230 (Th-230) source.
  - For typical beta detector function check, use a technetium-99 (Tc-99) or strontium/yttrium-90 (Sr/Y-90) source.
  - For typical function check of a high-energy gamma detector, use a cesium-137 (Cs-137) source.

- For low-energy gamma detector, such as a FIDLER, use an americium-241 (Am-241) source.

  Check sources used are dependent upon the goal of the survey. While the sources listed above are for typical function checks, they are not definitive.

- Calibration jig – Used to ensure consistent detector position relative to check source (geometry).
- C-cable – Used to connect detector and meter.
- Forms – SOP-02A *Single-Channel Function Check Log Form* and SOP-02B *Single-Channel QC Counts Form*, as needed.

3.2 Documentation – A function check log form (Form SOP-02A) must be created and maintained for each individual detector. The detector should be function checked before each day of use. The function check log form must be retained.

3.3 Initial Quality Control Counts – This section may be skipped if initial QC counts are determined to be unnecessary or already completed. This process is to identify initial detector response when first used on a project site, and to assist with identifying if a detector response changes over time while in use. If daily function check net counts are found to be within control limit range, the initial detector total efficiency and minimum detectable activity (MDA), where applicable, may be used.

- Fill in the meter, detector, source, and comments information on the SOP-02B *Single-Channel QC Counts Form*.
- SOURCE COUNTS – Place the source on to the calibration jig and place the detector in proper orientation. If using a scaler meter, begin a one-minute count. If using a ratemeter, let value stabilize. Record each measurement result on the QC log form.
- BACKGROUND COUNTS – Place the detector in proper orientation and position onto a clean calibration jig, where applicable. If using a scaler meter, begin a one-minute count. If using a ratemeter, let value stabilize. Record each background count on QC log form.
- NET COUNTS – For each set of counts calculate the net count (source count minus background count) and record on QC log form. Average the ten net counts and record on the QC log form in the appropriate location.

- ACCEPTABLE UPPER/LOWER NET COUNT RANGE – The upper and lower tolerances are 120-percent of and 80-percent of the ten net-count average value, respectively. Calculate these values and record in the appropriate location on the QC log form.

- INSTRUMENT EFFICIENCY – *NOTE: If using a non-NIST traceable source for function check then detector efficiency may be calculated using the data from the instrument calibration paperwork.* For alpha and beta detectors only, calculate the total efficiency for the detector using the average net count and source emission rate for the specific sourced used, then record efficiency in the appropriate location on the form. To calculate alpha and beta efficiencies use the following ISO 7503-1 (NUREG 1575/MARSSIM) equation:

$$E_t = e_i \times e_s$$

  Where:

  - E_t = Total efficiency (cpm/epm)
  - e_i = Instrument efficiency, where efficiency is calculated as the net detector response (cpm) divided by the check source surface emission rate (cpm). NOTE: The surface emission rate is not the total activity rate (dpm).
  - e_s = Source efficiency factor, where for alpha = 0.25, low energy beta (≤ 400 KeV) = 0.25, and high energy beta (> 400 KeV) = 0.50.

- MINIMUM DETECTABLE ACTIVITY (MDA) – *NOTE: If using a non-NIST traceable source for function check then MDA may be calculated using the data from the instrument calibration paperwork.* For alpha and beta detectors only with a scaler (timed counting) meter, calculate the MDA using the following equation:

$$MDA = \frac{2.71 + 3.29\sqrt{C_{background} \times t_{sample} \times \left(1 + \frac{t_{sample}}{t_{background}}\right)}}{t_{sample} \times E_t}$$

  Where:

  - MDA = minimum detectable activity with 95% confidence (dpm/100 cm^2)
  - $C_{background}$ = Counts from background in time, t (counts)
  - t_{sample} = Sample counting time (minutes)
  - $t_{background}$ = Background counting time (minutes)
  - E_t = Total efficiency (cpm/epm)

3.4 Daily Function Check – Not all meters and detectors have the same features or function check needs. When unsure, check the manufacturer's Technical Manual for confirmation and/or assistance.

- If not already done, fill in the meter, detector, source, and comment information on the function check log form SOP-02A *Single-Channel Function Check Log*. If initial QC counts have been performed, review form SOP-02B *Single-Channel QC Counts Form* associated with the detector to find and record the upper and lower acceptable net count rates (control limits), detector total efficiency, and detector MDA, as needed. If not applicable for the detector type, then record "N/A".

- PHYSICAL INSPECTION – Check the meter, detector, and cable for any visible damage. If damage is present then repair, or tag and remove from service. Check the meter calibration date and confirm meter and detector are in calibration. If not in calibration, then remove from service until it has been calibrated.

- TURN ON – Connect the detector and meter using the C-cable, then turn the instrument power on.

- BATT CHECK – Turn the instrument to the BATT position. Note the condition of battery as indicated by display. If the battery power is marginal (as indicated by the needle below the BATT OK level on analog meter face, below 4.4 on Ludlum Model 2221, or when battery indicator appears on Ludlum Model 2241), the batteries should be replaced. If battery level is acceptable then indicate on the function check log form with a check mark in the Battery Condition box.

- HV CHECK – Toggle the RESET/TEST HV switch or press the HV button and check the meter operating high voltage (HV). If the HV is within ± 25V of the recommended operating HV, as found on the detector calibration certificate paperwork and calibration sticker, then record on the function check log form. If not, adjust HV accordingly, or tag and remove from service.

- SOURCE COUNT – Place the source on to the calibration jig and place the detector in proper geometry and orientation. If using a scaler meter, begin a one-minute count. If using a ratemeter, let value stabilize. Upon completion, record the source counts onto the function check log form.

- BACKGROUND COUNT – Place the detector in proper orientation and position onto a clean calibration jig (where applicable). If using a scaler meter, begin a one-minute count. If using a ratemeter, let value stabilize. Upon completion, record the background counts onto the function check log form.

- NET COUNTS – If the net count result is acceptable (within upper/lower control limit range), then the individual performing the function check should record their initials in the appropriate box on the function check form upon completion of the function check. If the net count result is not acceptable, then repeat counts.

  NOTE: If the net results are not within control limit range, then confirm you are using the correct detector-to- jig geometry and perform a repeat count. If the second count is also outside of control limit range, remove detector from service until issue can be resolved. Notify/consult with the Field Services Manager and/or Radiation Safety Officer.

4. REFERENCES

4.1 Manufacturer's Technical Manuals for the meter and detector being checked. NOTE: Ludlum Technical manuals are also available on their webpage; http://www.ludlums.com

4.2 ANSI N323A-1997, American National Standard Radiation Protection Instrumentation Test and Calibration

4.3 ISO 7503-1:2016 Measurement of Radioactivity – ANSI

4.4 NUREG 1575 Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)

5. ATTACHMENTS

5.1 Form SOP-02A – Single-Channel Function Check Log

5.2 Form SOP-02B – Single-Channel QC Counts Form

ATTACHMENTS

Single-Channel Function Check Log

METER	
Manufacturer:	
Model:	
Serial No.:	
Cal. Due Date:	

DETECTOR	
Manufacturer:	
Model:	
Serial No.:	
Cal. Due Date:	

Comments:
Scaler Count Time:
Distance To Source:

Source: _____ Serial No.: _____ Activity: _____ uCi Emission Rate: _____ cpm/emissions Source Date: _____

NOTE: For use as needed. Acceptable upper/lower net counts, detector total effiiciecy, and detector MDA calculated on Form SOP-02B .

Acceptable Upper Net Counts:		Total Efficiency (E_t):	
Acceptable Lower Net Counts:		MDA (dpm/100-cm²):	

Date	Time	Battery	High Voltage	Threshhold	Source Counts	BKG Counts	Net Counts	Initials	Note(s):

Reviewed by: _____ **Review Date:** _____

Single-Channel QC Counts Form

METER	
Manufacturer:	
Model:	
Serial No.:	
Cal. Due Date:	

DETECTOR	
Manufacturer:	
Model:	
Serial No.:	
Cal. Due Date:	

Source: _____ Activity : _____ µCi Source Date: _____

Serial No.: _____ Emission Rate: _____ cpm/emissions Dist. to Source: _____

Observation	Gross Source Counts (cpm)	Background Counts (cpm)	Net Counts (cpm)	Comments:
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
Average Net Count Rate(s)				
Upper Acceptable Net Count Rate (Average + 20%)				
Lower Acceptable Net Count Rate (Average - 20%)				

NOTE: For Alpha and Beta Detector only. No efficiency or MDA calculation for Gamma Detectors.

Total Efficiency $E_t = e_i \times e_s$	
$MDA = \frac{2.71 + 3.29\sqrt{C_{background} \times t_{sample} \times \left(1 + \frac{t_{sample}}{t_{background}}\right)}}{t_{sample} \times E_t}$	

Performed by: _____ **Date:** _____

Reviewed by: _____ **Date:** _____

Disa Technologies, Inc.

SOP-03 Rev. 0

Operational Checkout of Dual-Channel Alpha/Beta Detector with Meter

Standard Operating Procedure

Approvals

_____ _____

Chief Operating Officer *Date*

_____ _____

Radiation Safety Officer *Date*

REVISION LOG		
Revision Number	**Description of Changes**	**Pages Affected**
0	**Initial Release**	**All**

1. PURPOSE

To provide a method for the operational checkout, or "function check" of a dual-channel alpha/beta meter and detector pair to ensure proper working condition of the instruments.

2. DISCUSSION

A radiological survey detector (detector) is used with a compatible radiological survey meter (meter) to measure radiation in integrated scaler count and/or rate modes. This standard operating procedure (SOP) is specific to dual-channel alpha/beta detectors compatible for use with a dual-channel meter. A dual-channel meter counts alpha detections in one channel and the beta detections in another channel. In some cases, the detector and meter may be contained in a single housing. For this SOP, the detector and meter combination will be referred to as the detector only.

During the operational check-out process (function check), the detector is also inspected for any physical damage that might affect functionality, such as punctured mylar or cracked housing. An aluminized mylar window covering (mylar) is used to eliminate light from entering the detector window. If this mylar is punctured, even slightly, it may return inaccurately readings. Repair or replace mylar windows, as necessary, noting the repair/replacement on the Form SOP-03A *Dual-Channel Function Check Log Form*.

Calibration of any survey detector is required prior to initial use, at least annually, and after any scheduled or unscheduled maintenance or repair that may affect instrument operation. Initial quality control (QC) source counts are made to established acceptable, baseline, instrument operating ranges (control limits). The detector response is compared against the control limits daily to identify if the instrument is working properly and consistently.

3. PROCEDURE

3.1 Equipment – The necessary components to function check a radiological survey detector.

- Radiological survey detector –
  Ludlum Model 43-93 detector (zinc sulfide + plastic, alpha/beta), Ludlum Model 43-10-1 tray counter, or similar.
- Calibrated dual-channel meter –
  Ludlum Model 2360, Ludlum Model 2929, or similar.

- Radiological check sources –
  - For typical function check of an alpha detector, use a thorium-230 (Th-230) source.
  - For typical beta detector function check, use a technetium-99 (Tc-99) or strontium/yttrium-90 (Sr/Y-90) source.

  Check sources used are dependent upon the goal of the survey. While the sources listed above are for typical calibrations, they are not definitive.
- Calibration jig – Used to ensure consistent detector position relative to check source (geometry).

  NOTE: For tray counter calibration and checkout a calibration jig is not necessary and any reference to one in the steps below may be disregarded.

- C-cable to connect detector and meter.
- Form SOP-03A *Dual-Channel Function Check Log Form* and SOP-03B *Dual-Channel QC Counts Form*, as needed.

3.2 Documentation – A function check log form (Form SOP-03A) must be created and maintained for each individual detector. The detector should be function checked before each day of use. The function check log form must be retained.

3.3 Initial Quality Control Counts – This section may be skipped if initial QC counts are determined to be unnecessary or already completed. This process is to identify initial detector response when first used on a project, and to assist with identifying if a detector response changes over time while in use. If daily function check net counts are found to be within control limit range, the initial detector total efficiencies and minimum detectable activities (MDA), where applicable, may be used.

- Fill in the meter, detector, source, and comments information on the SOP-03B *Dual-Channel QC Counts Form*.
- SOURCE COUNTS – Place the source on to the calibration jig and place the detector in proper orientation. Make ten alpha source count measurements and ten beta source count measurements. Record the α Alpha channel and β Beta channel measurement results on the QC log form in the appropriate channel boxes.

- BACKGROUND COUNTS – Place the detector in proper orientation and position onto a clean calibration jig, where applicable. Record both the alpha and beta channel background counts on QC log form.

- NET COUNTS – For each set of counts alpha and beta channel counts, calculate the net count (source count minus background count) and record on QC log form. Average the ten net counts for each channel and record on the QC log form in the appropriate location.

- ACCEPTABLE UPPER/LOWER NET COUNT RANGE – The upper and lower tolerances are 120-percent of and 80-percent of the ten net-count average value for each channel, respectively. Calculate these values and record in the appropriate location on the QC log form.

- INSTRUMENT EFFICIENCY – *NOTE: If using a non-NIST traceable source for function check then detector efficiency may be calculated using the data from the instrument calibration paperwork.* For alpha and beta detectors only, calculate the total efficiency for the detector using the average net count and source emission rate for the specific sourced used, then record efficiency in the appropriate location on the QC log form. To calculate alpha and beta efficiencies use the following ISO 7503-1 (NUREG 1575/MARSSIM) equation:

$$E_t = e_i \times e_s$$

  Where:

  - E_t = Total efficiency (cpm/epm)
  - e_i = Instrument efficiency, where efficiency is calculated as the net detector response (cpm) divided by the check source surface emission rate (cpm). NOTE: The surface emission rate is not the total activity rate (dpm).
  - e_s = Source efficiency factor, where for alpha = 0.25, low energy beta (≤ 400 KeV) = 0.25, and high energy beta (> 400 KeV) = 0.50.

- MINIMUM DETECTABLE ACTIVITY (MDA) – *NOTE: If using a non-NIST traceable source for function check then MDA may be calculated using the data from the instrument calibration paperwork.* For alpha and beta detectors only with a scaler (timed counting) meter calculate the MDA using the following equation:

$$MDA = \frac{2.71 + 3.29\sqrt{C_{background} \times t_{sample} \times \left(1 + \frac{t_{sample}}{t_{background}}\right)}}{t_{sample} \times E_t}$$

Where:

- MDA = minimum detectable activity with 95% confidence (dpm/100 cm^2)
- $C_{background}$ = Counts from background in time t (c)
- t_{sample} = Sample counting time (minutes)
- $t_{background}$ = Background counting time (minutes)
- E_t = Total efficiency (cpm/epm)

3.4 Function Check – Not all meters and detectors have the same features or function check needs. When unsure check the manufacturer's Technical Manual for confirmation and/or assistance.

- If not already done, fill in the meter, detector, source, and comments information on the function check log form SOP-03A *Dual-Channel Function Check Log*. If initial QC counts have been performed, review form SOP-03B *Dual-Channel QC Counts Form* associated with the detector to find and record the upper and lower acceptable net count rates (control limits) for both alpha and beta channels, detector total efficiencies, and detector MDAs, as needed. If not applicable for the detector type, then record "N/A".
- PHYSICAL INSPECTION – Check the meter, detector, and cable for any visible damage. If damage is present then repair, or tag and remove from service.
- TURN ON – Connect the detector and meter using the C-cable, then turn the instrument power on.
- BATT CHECK – Turn the instrument to the BATT position. Note condition of battery as indicated by display. If the battery power is marginal (as indicated by the needle below the BATT OK level on analog meter face), the batteries should be replaced. If battery power is acceptable then indicate on the function check form with a check mark in the Battery Condition box. *NOTE: For instruments that are AC powered this step may be ignored and an "N/A" recorded in Battery Condition box.*

- HV CHECK – Toggle the RESET/TEST HV switch and check the meter operating high voltage (HV). If the HV is within ± 25V of the recommended operating HV as found on the detector calibration paperwork and calibration sticker then record on the function check form. If not, then adjust accordingly or tag and remove from service.

- ALPHA SOURCE COUNT – Place the alpha source on to the calibration jig or in tray, place the detector in proper orientation and position over the source or close and lock tray, and begin a one-minute count. Upon completion record the alpha and beta channel counts for the alpha source onto the function check form.

- BETA SOURCE COUNT – Place the beta source on to calibration jig or in tray, place the detector in proper orientation and position over the source or close and lock tray, and begin a one-minute count. Upon completion record the alpha and beta channel counts for the beta source onto the function check form.

- BACKGROUND COUNT – Place the detector in proper orientation and position onto a clean calibration jig (where applicable) and begin a one-minute count. Upon completion record the alpha and beta channel background counts onto the function check form.

- NET COUNTS – The net alpha channel counts are equal to the alpha source alpha channel (α Alpha) counts less the background alpha channel counts. The net beta channel counts are equal to the beta source beta channel (β Beta) counts less the background beta channel counts. If the net count results are acceptable (within upper/lower control limit range) for both channels, then the individual performing the function check should record their initials in the appropriate box on the function check form upon. If the net count results are not acceptable then repeat counts.

  NOTE: If the net results are not within control limit range, then confirm you are using the correct detector-to-jig geometry and perform a repeat count. If the second count is also out of control limit range, remove detector from service until issue can be resolved and notify/consult with the Field Services Manager and/or Radiation Safety Officer.

4. REFERENCES

4.1 Manufacturer's Technical Manuals for the meter and detector being checked. NOTE: Ludlum Technical manuals are also available on their webpage; http://www.ludlums.com

4.2 ANSI N323A-1997, American National Standard Radiation Protection Instrumentation Test and Calibration

4.3 ISO 7503-1:2016 Measurement of Radioactivity – ANSI

4.4 NUREG 1575 Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)

5. ATTACHMENTS

5.1 Form SOP-03A – Dual-Channel Function Check Log

5.2 Form SOP-03B – Dual-Channel QC Counts Form

ATTACHMENTS

Dual-Channel QC Counts Form

METER	
Manufacturer:	
Model:	
Serial No.:	
Cal. Due Date:	

DETECTOR	
Manufacturer:	
Model:	
Serial No.:	
Cal. Due Date:	

Alpha (α) Source: _____ Serial No.: _____ Emission Rate: _____ cpm/emissions

Beta (β) Source: _____ Serial No.: _____ Emission Rate: _____ cpm/emissions

Comments: _____

_____

Observation	Gross α Alpha Counts (cpm)	Gross β Beta Counts (cpm)	BKG Alpha Counts (cpm)	BKG Beta Counts (cpm)	Net α Alpha Counts (cpm)	Net β Beta Counts (cpm)
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
Average Net Count Rate(s)						
Upper Acceptable Net Count Rate (Average + 20%)						
Lower Acceptable Net Count Rate (Average - 20%)						
Total Efficiency $E_t = \varepsilon_i \times \varepsilon_p$						
Minimum Detectable Activity $\frac{2.71 + 3.29\sqrt{C_{background} \times t_{sample} \times \left(1 + \frac{t_{sample}}{t_{background}}\right)}}{t_{sample} \times E_t}$						

Performed by: _____ **Date:** _____

Reviewed by: _____ **Date:** _____

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Disa Technologies, Inc.

SOP-04 Rev. 0

Guidelines for Handling Radioactive Material

Standard Operating Procedure

Approvals

Chief Operating Officer	*Date*
Radiation Safety Officer	*Date*

REVISION LOG		
Revision Number	**Description of Changes**	**Pages Affected**
0	**Initial Release**	**All**

1. PURPOSE

The purpose of this procedure is to offer general radiation protection and exposure limiting guidelines when personnel are handling radioactive materials. Work may be performed under additional standard operating procedures during specific activities to control exposures and prevent the spread of radiological contamination.

Radioactive materials must be handled or used in a manner as to prevent radiation exposure greater than regulatory authority limits. Additionally, all workers must attempt at all times to keep personnel exposures within project established administrative limits and As Low As Reasonably Achievable (ALARA), regardless of the regulatory upper limits

2. RESPONSIBILITIES

2.1 Radiation Safety Officer (RSO), Assistant Radiation Safety Officer (ARSO) –

- All appropriate project/site personnel are properly trained on ALARA principles, as related to handling of radioactive materials.
- Radiological surveys are performed to provide current information on the radiological environment(s) to which personnel are potentially exposed, as needed.
- Appropriate tools and personal protective equipment (PPE), dosimetry and radiological instrumentation are provided, as needed.

2.2 Field Services Manager (FSM) –

- Support the RSO, AU, and ALARA program.
- Inform the RSO of any changes to site procedures or schedule that could affect radiation protection.

2.3 Radiation Safety Technician (RST) –

- Report to the RSO and FSM on all radiological matters, where appropriate.
- Perform radiological surveys to provide current information on the radiological environments(s) to which personnel are potentially exposed, as needed.
- Manage onsite PPE, dosimetry, and radiological instrumentation, as needed, and ensure proper recordkeeping, instrument calibrations, and maintenance.
- Properly handle radioactive materials, per guidelines of this procedure.

2.4 Authorized Users (AU) –

- Attend training and briefings on radiation protection and RWPs.
- Properly use, wear, and don/doff all PPE.
- Not handle radioactive material unless trained to properly do so, per guidelines of this procedure.

3. PROCEDURE

Handling of Sealed Sources and Radiation Producing Devices – Sealed sources and radiation producing devices are external sources of radiation. External radiation dose must be kept ALARA. The following ALARA principles of time, distance, and shielding shall be applied. In addition:

- Take care not to subject the source(s) to physical or thermal shock greater than source design specifications.
- For higher activity sources (i.e., greater than 100 µCi beta/gamma or 10 µCi alpha):
    - Consider handling with tweezers, tongs, or handling tool.
    - When practical, hold the source at arm's length to increase distance from the body, and avoid having the source come in contact with any part of the body.

Handling of Unsealed Sources - Radioactive materials in any readily dispersible form shall be considered unsealed sources. Unsealed sources present additional potential problems of contamination and human internal intake by adsorption, oral ingestion, and/or inhalation that are not usually present with sealed sources. The following safety precautions shall be followed when working with unsealed sources:

- Do not eat, drink, or use tobacco/vape in area containing unsealed sources.
- Store and transport unsealed sources in such a manner as to prevent spillage or dispersal, and use spill containment, such as trays or secondary containment, whenever possible.
- Wear proper PPE as prescribed by the RSO. PPE could include protective gloves, protective coveralls, booties, respiratory equipment, safety glasses, and/or face shields.
- After working with unsealed sources perform a personnel contamination survey with appropriate radiological survey instrumentation, and wash hands and arms before handling any object that goes to the mouth, eyes, or nose.
- When in doubt of radiological hazards, consult the RSO, ARSO, or RST.

Guidelines for Control of Contamination – Cleanliness and orderliness are two of the most important methods of minimizing contamination.

- Keep the work area neat and clean, free from equipment and materials not necessary in the operation.
- Spill containment should be used whenever possible when working with unsealed radioactive materials.
- If contamination is suspected contact the RSO, AU, or RST who will survey the area and persons involved to determine the degree of contamination and to institute proper cleanup and decontamination procedures.
- Material and equipment that come in contact with unsealed sources should be kept separate from other uncontaminated equipment. Once equipment and tools are used with radioactive substances, they should be marked appropriately, temporarily stored in controlled access areas limited for radiological use only. Only after a survey to demonstrate that the tools and equipment are free from contamination shall it be allowed for unrestricted use.
- Periodic area radiation surveys and or area removable contamination surveys shall be conducted as specified by the RSO or AU.

Storage and Shipment of Radioactive Materials – Radioactive materials that are under the jurisdiction of the US NRC, or Agreement State regulatory authority shall be stored and/or shipped in such a manner as to minimize radiation exposure.

- Containers in which radioactive materials are stored shall be properly labeled in accordance with 10 CFR Part 71, 49 CFR Parts 170 to 177, or other appropriate regulatory labeling requirements.
- Radioactive gases or materials with radioactive gaseous daughters should be stored in gas-tight containers and should be kept in areas with good ventilation.
- Unsealed sources should be stored in such a manner as to contain the material in case of spillage or breakage. Radioactive materials that are stored in unrestricted areas shall be secured from unauthorized access and removal (e.g., awaiting pickup for transportation).

- Radioactive materials to be shipped or transported on public highways shall comply with NRC and US DOT shipping regulations. All personnel shipping radioactive material (Class 7) will be trained in accordance with US DOT regulations. Other procedures may further detail the receipt and shipment of radioactive material.
- The RSO or ARSO shall be informed prior to any shipment, transport, or transfer of radioactive material, and will be notified immediately of receipt of receipt of radioactive material.

Waste Disposal – Any wastes must be controlled for the safety of personnel and the general public in the same manner as other radioactive materials. Classification and disposal of waste must conform to Federal and State regulations.

- Each project creating radioactive waste shall have properly labelled containers for solid and liquid radioactive wastes, as necessary.
- A record of all waste shall be kept by the RSO, ARSO, or RST indicating, as completely as practicable, contents, radionuclide identity and quantity and the principal chemical and physical form. A record of all radioactive waste disposal shall be retained.

4. REFERENCES

4.1 Radiation Protection Program (RPP) Manual

Disa, Inc.

SOP-05 Rev. 0

Radiological Area Access and Posting

Standard Operating Procedure

Approvals

_____ _____

Chief Operating Officer *Date*

_____ _____

Radiation Safety Officer *Date*

REVISION LOG		
Revision Number	**Description of Changes**	**Pages Affected**
0	**Initial Release**	**All**

1. PURPOSE

The purpose of this procedure is to provide instruction on controlling access to and posting of radiological area(s) and licensed radioactive materials.

Adherence to this procedure will provide reasonable assurance that licensed material will remain secure at all times, contamination of personnel will be minimized, contamination spread will be minimized beyond the designated controlled areas, and personnel exposures will be As Low As Reasonably Achievable (ALARA).

2. RESPONSIBILITIES

2.1 Radiation Safety Officer (RSO), Assistant Radiation Safety Officer (ARSO) –

- Radiological areas are identified.
- Necessary access controls of radiological areas are established.
- Appropriate postings (radiation, airborne, contamination, etc.) are in place.
- Exposure monitoring of personnel working within a radiological area is performed, as necessary.

2.2 Field Services Manager –

- Support the RSO, ARSO, AUs, and ALARA program.
- Inform the RSO of any changes to site procedures or schedule that could affect radiation protection.

2.3 Radiation Safety Technician (RST) –

- Report to the RSO and PM on all radiological matters and the onsite management and implementation of the ALARA program.
- Establish and maintain necessary access controls and posting of radiological areas.
- Monitor for exposure, as necessary, or as directed by RSO or ARSO.

2.4 Authorized Users (AU) –

- Attend training and briefings on radiation protection.
- Comply with all radiological restricted area access controls (barricades, barriers, and gates) and postings.
- Not enter radiological areas unless trained properly to do so.

3. PROCEDURE

NOTE: Access control prevention measures shall NOT be installed at radiological restricted area exits that would prevent rapid evacuation of personnel under emergency conditions.

3.1 General Access Controls – Personnel entry shall be controlled at project sites and to specific radiologically controlled or restricted areas.

- The degree of access control shall be commensurate with the existing and potential radiological hazards within the area. One or more of the following methods shall be used to ensure entry control at access points to licensed radiological areas:
  - Signs and barricades.
  - Control devices on entrances.
  - Conspicuous visual and/or audible alarms.
  - Locked entrance.
  - Additional controls, as approved by the RSO, ARSO, or AU and specified in a radiological work permit (RWP) or other existing approved technical work document.
- Personnel dosimetry may be required for entry.
- When posting is required, a sign shall be placed on each entrance door or fenced area. If the area to be posted is not a room or fenced area, the area containing the licensed material shall be bounded by a yellow and magenta/black rope or ribbon securely fastened to stanchions, posts or other durable devices and signs shall be displayed in all accessible directions.
- RWP's shall be implemented, as needed, to specify radiological protection and monitoring measures commensurate with existing and potential hazards.

3.2 Controlled Areas – A Controlled Area is an area outside of a restricted area but within the site boundary, to which the licensee can limit access for any reason.

- Controlled Areas shall have signs conspicuously posted at each access point.
- Entry into these areas is limited to those personnel who have met the site training requirements; who have had site-specific training; who have met any special requirements as specified by license designated RSO; and who have a need to enter.
- Access shall be documented using the SOP-04-A - *Controlled Area Access Log Form*, or similar.

- Visitors may be escorted into a Controlled Area by someone who meets all Controlled Area access requirements.

3.3 Restricted Areas – A restricted area is an area where radioactive materials are used, handled, or stored. Restricted areas will encompass all equipment that will be used to perform the licensed activities and will be large enough to prevent unnecessary doses to members of the public.

- Any area or room in which there is used or stored an amount of licensed material exceeding 10 times of the quantity of such material specified in Appendix B to10 CFR Part 20 shall be identified and posted with a sign that indicates "CAUTION RADIOACTIVE MATERIALS AREA" or "DANGER, RADIOACTIVE MATERIALS".
- Entry into a restricted area is limited to those personnel who:
  - Have met the training requirements,
  - Have met any special requirements as specified by the RSO,
  - Have a need to enter.
- Entry into a specifically posted restricted area (e.g., Radiation/High Radiation/Very High Radiation Area, Contamination/High Contamination Area and/or Airborne Radiation Area) is limited to those personnel who have read and signed an approved RWP for the area.

3.4 Radiation, High Radiation, and Very High Radiation Areas

- RADIATION AREA (RA) is any area with radiation levels greater than 5 millirem (0.05 millisievert) in one hour at 30 centimeters from the source or from any surface through which the radiation penetrates. *NOTE: A calibrated dose/exposure rate meter may be used to identify the boundary location of the 5 mrem/hr dose rate.*
  - Any area accessible to personnel in which there exists ionizing radiation at dose rate levels such that an individual could receive a deep dose equivalent in excess of 5 mrem in 1 hour at 30 cm from the source of from any surface that the radiation penetrates shall be identified and posted with a sign that indicates "CAUTION RADIATION AREA".
  - If an entire room or most of the room is at or above the 5 mrem/hr level, a sign should be placed on each entrance door to the room.

- If the area to be posted is not a room, the area at or above the 5 mrem/hr level shall be bounded by a yellow and magenta/black rope or ribbon securely fastened to stanchions, posts or other durable device and signs shall be displayed in all accessible directions.
- An exemption to this posting requirement is allowed in areas or rooms containing radioactive materials for periods less than 8 hours, if both the materials are constantly attended to during these periods by an individual who takes the precautions necessary to prevent the exposure to radiation or radioactive materials in excess of the limits specified in the Radiation Protection Program, and the area or room is subject to the licensee's control.

- HIGH RADIATION AREA (HRA) is any area with dose rates greater than 100 millirems (1 millisievert) in one hour at 30 centimeters from the source or from any surface through which the ionizing radiation penetrates. A Very High Radiation Area (VHRA) is an area accessible to individuals, in which radiation levels exceed 500 rad (5 gray) in one hour at one meter from the source or from any surface that the radiation penetrates.

  NOTE: It is not anticipated that Disa will ever work in an HRA or VHRA, it is important that Disa personnel be familiar with the HRA and VHRA designation.

  - High and very high radiation areas shall be identified and posted with a sign that indicates "CAUTION, HIGH RADIATION AREA" or "DANGER, HIGH RADIATION AREA" for HRA, and "GRAVE DANGER, VERY HIGH RADIATION AREA" for VHRA.
  - One or more of the following features shall be used for each entrance or access point to a HRA where radiation levels exist such that an individual could exceed a deep dose equivalent to the whole body of 1 rem (0.01 Sievert) in any 1 hour at 30 cm from the source or from any surface that the radiation penetrates:
    - Entryways that are locked except during periods when access to the area is required, positive control over each entry is maintained.
    - Continuous direct or electronic surveillance that is capable of preventing unauthorized entry.
    - A control device that prevents entry to the area when high radiation levels exist or, that upon entry causes the radiation level to be reduced below the level that defines a high radiation area.

- A control device that energizes a conspicuous visual or audible alarm signal so that the individual entering the high radiation area and the supervisor of the activity are made aware of the entry.
- A control device that will automatically generate audible and visual alarm signals to alert personnel in the area before use or operation of the radiation source and in sufficient time to permit evacuation of the area or to permit activation of a secondary control device capable of preventing use or operation of the source.
- A device that functions automatically to prevent use of or operation of the radiation source or field while personnel are in the area.
- In addition to the above controls, other physical controls may be used for entry control to an HRA, and additional measures shall be implemented to ensure that individuals are not able to gain unauthorized or inadvertent access to a VHRA.

  - Entry into RA/HRA/VHRA are limited to those personnel who have met the training requirements; who have read and signed an approved RWP, if applicable; and who are wearing the appropriate personnel dosimetry.
  - Work in HRA and VHRA requires the licensed designated RSO has been provided a dose history for an individual to work in these areas.
  - Continuous RST coverage shall be provided while work occurs.

3.5 Contamination, High Contamination, and Airborne Contamination Areas

- CONTAMINATION AREA (CA) – A Contamination Area is an area that has fixed and removable radioactive materials in the form of dusts, particulates or absorbed contaminants which are above the limits specified in the Radiation Protection Program Manual. Contamination may be airborne or deposited in (or on the surface of) structures, objects, soil, water, or living organisms in a concentration that makes the medium unfit for its next intended use.
  - A CA shall be identified and posted with a sign that indicates “CAUTION, CONTAMINATION AREA”.
- HIGH CONTAMINATION AREA (HCA) – A High Contamination Area is a CA that is 100 times above the limits specified in the Radiation Protection Program Manual.
  - A HCA shall be identified and posted with a sign that indicates “CAUTION, HIGH CONTAMINATION AREA”

- AIRBORNE RADIOACTIVTY AREA (ARA) – An Airborne Radioactivity Area is a CA that is a room, enclosure, or other area in which airborne radioactive materials in concentrations that:
  - exceed the derived air concentration limits (DACs), OR
  - would result in an individual present in the area, without respiratory protection, exceeding (during the hours an individual is present in a week) 0.6% of the annual limit on intake (ALI) or 12 DAC-hours, as specified in Appendix B to 10 CFR Part 20.
- A room, enclosure or area shall be posted with a sign that indicates "CAUTION, AIRBORNE RADIOACTIVITY AREA" or "DANGER, AIRBORNE RADIOACTIVITY AREA" if radioactive material is dispersed in the form of fumes, dusts, mists, vapors, or gases and the contamination of the dispersed radioactive materials is in excess of limits above.
- Entry into CA/HCA/ARA are limited to those personnel who have met the training requirements; who have read and signed an approved RWP, if applicable; and who are wearing the appropriate personnel protective equipment (PPE) and dosimetry.
- Personnel exiting a CA, HCA or ARA shall remove PPE and respiratory protection (if respiratory protection is required) and shall perform a whole-body contamination survey (frisk). If background radiation levels or other conditions at the exit point preclude performance of personnel frisking, the exit point should be relocated to an area of lower background levels. If relocation of the exit point is not practicable, individuals should proceed directly from the exit point to an appropriate area to perform a whole-body frisk.

4. REFERENCES

4.1 Radiation Protection Program (RPP) Manual

5. ATTACHMENTS

5.1 SOP-05A Controlled Area Access Log Form

Form SOP-05-A Controlled Area Access Log Form

Site _____

Name	Date	Time In	Time Out	Respirator (Y or N)	Work Area

Reviewed By: _____ Date_____ Ver. 0, Created 5/19/2021

Disa Technologies, Inc.

SOP-06 Rev. 0

Radiation Contamination Surveys and Decontamination

Standard Operating Procedure

Approvals

_____ _____

Chief Operating Officer *Date*

_____ _____

Radiation Safety Officer *Date*

REVISION LOG		
Revision Number	**Description of Changes**	**Pages Affected**
0	**Initial Release**	**All**

1. PURPOSE

This procedure describes the methods for conducting radiological contamination surveys for personnel and equipment at Disa, Inc. project sites. This procedure covers multiple types of radiological contamination surveys that may be required under the Radiation Protection Program (RPP) or a Radiation Work Permit (RWP), including fixed or removable contamination involving alpha, beta and/or gamma radiation(s) on personnel or equipment (or some combination thereof). The type(s) of survey(s) specified in the RPP or RWP may vary depending on the nature of the work, potential for contamination, and survey objectives.

2. RESPONSIBILITIES

2.1 Radiation Safety Officer (RSO), Assistant Radiation Safety Officer (ARSO) –

- Appropriate types of radiological surveys or monitoring are selected.
- Appropriate instrumentation to perform these surveys are specified.

2.2 Field Services Manager (FSM) –

- Support the RSO, ARSO, AU, and the Radiation Protection Program.
- Provide necessary resources to implement provisions in RPP and RWPs.

2.3 Radiation Safety Technician (RST) –

- Be responsible for onsite management and implementation of RPP and RWPs that include radiological contamination surveys.
- Perform daily instrument QC checks, radiological surveys, and maintain documentation, as necessary.

2.4 Authorized Users (AU) –

- Comply with the Radiation Protection Plan (RPP) and Radiation Work Permit (RWP) requirements regarding all radiological contamination surveys.

3. PROCEDURE

3.1 Equipment and Materials

- Radiation survey instruments, as specified in RPP and/or RWPs.

- Materials and equipment as needed for instrument function checks and efficiency determinations (per SOP-02 and SOP-03) including calibrated check sources and standard geometry devices (i.e., calibration jig)
- Suggested: Camera (e.g., cell phone camera) to document equipment being released, and to identify the locations surveyed on a photo diagram as indicated on Form SOP-3A.

3.2 Preliminary Measurements

- Before a contamination survey is conducted, preliminary measurements are required to verify and document proper instrument response performance (function checks), and to determine instrument counting efficiency (number of counts detected per radioactive decay), where applicable. These measurements and calculations will be performed in accordance with applicable specifications of SOP-02 and SOP-03, depending on the equipment type.

3.3 Equipment Release Surveys

- Equipment release surveys consist of scans, static measurements, and removable swipe measurements to identify and quantify radiological contamination from alpha, beta, and gamma radiations.

3.3.1 Release Criteria

- Generally speaking, equipment that meets the release limits for total and removable alpha activity on surfaces will meet U.S. Nuclear Regulatory Commission (NRC) criteria for unrestricted release from a uranium recovery facility as indicated in U.S. NRC Regulatory Guide 8.30 (NRC, 2002). Corresponding regulatory limits, along with administrative limits and limits for UN2910 excepted packages[1], are given in Table 3-1.

[1] For shipping small quantities of radioactive material (e.g., samples for laboratory analysis).

Table 3-1: Regulatory and Administrative Contamination limits.

Category	Parameter	Regulatory Limit [1]	Administrative Limit [1]
Contamination Limits	Personnel	1,000 dpm/100 cm² [4]	Background
	Equipment Release	5,000 dpm/100 cm² [2] 15,000 dpm/100 cm² [3] 1,000 dpm/100 cm² [4]	200 dpm/100 cm², 25 µR/hr
	UN2910 Excepted Packages	24 dpm/cm² [5] 240 dpm/cm² [6] 500 µR/hr [7]	N/A

[1] Note that limits for personnel and equipment apply only to licensed radioactive materials, but broader application to all radioactive materials is an ALARA goal for Site operations. All limits are net (above background) values.

[2] Average total (fixed plus removable) alpha (or beta) activity across any 1-m² area (NRC Reg Guide 8.30).

[3] Maximum total alpha (or beta) activity across any 100-cm² area (NRC Reg Guide 8.30).

[4] Removable gross alpha (or beta) surface activity above background (NRC Reg Guide 8.30).

[5] Removable alpha activity on package surface (average across 300 cm² area).

[6] Removable beta/gamma activity on package surface (average across 300 cm² area).

[7] Gamma exposure rate on contact with package.

3.3.2 Calculation of Surface Activity for Alpha or Beta Radiation

Once measurements of the count rate (CPM) for total (fixed + removable) contamination or removable contamination (swipe samples) have been taken, the measured count rate must be converted to units of surface activity for comparison against the limits given in Table 3-1. The formula for calculation of surface activity is given by Equation 3-1.

$$C = \frac{R_S - R_B}{\varepsilon_t\left(\frac{A}{100}\right)} \qquad \textbf{Equation 3-1}$$

Where:

- C = surface activity concentration (DPM/100 cm²).
- R_S = detector count rate for the surface or sampling media (CPM).
- R_B = background count rate for "clean" surface or unused sampling media (CPM).
- ε_t = total detection efficiency (counts/decay), as determined in SOP-03.
- A = areal dimensions (cm²) of active probe area (for static surface counts), or of the area swipe tested (for removable). Note that replacing the ratio A/100 in the above formula with the value of "A" alone will give the activity in units of DPM/cm².

3.3.3 Gamma Scans

Equipment that has the potential to contain residual radioactive materials in interior void spaces (sample packaging, piping, tanks, machinery, etc.) requires a gamma exposure rate scan. All accessible surfaces should be scanned with the detector on, or in close contact with, surfaces of any item to be released for unrestricted use, or for UN2910 shipping. Investigate any areas with clearly elevated readings, including with subsequent alpha/beta measurements. Results must be documented on the Form SOP-06A *Equipment Release Survey Form*.

If the measured net exposure rate across accessible surfaces is less than 25 µR/hr above background, the item is a candidate for unrestricted release providing that it meets the alpha and beta surface contamination limits given in Table 3-1.

For samples of radioactive material that will be shipped to a commercial laboratory under UN2910 excepted package protocols, the net exposure rate must be less than 500 µR/hr at any point of contact on the exterior of the outer shipping container. For more detailed instructions on UN2910 shipping, see SOP-10.

3.3.4 Alpha/Beta Scans for Surface Activity

Surveys for radioactive surface contamination shall be performed and results evaluated against applicable release criteria specified in Table 3-1 for all equipment, vehicles, or materials that could potentially become radiologically contaminated. Consistent with specifications found in NRC Regulatory Guide 8.30 (NRC, 2002), surveys for alpha activity alone are normally sufficient to demonstrate compliance with release limits.

However, items with the potential for penetration of contamination below the surface, should also be surveyed for beta activity. Examples include items comprised of wood or other porous material. If in doubt, also perform a beta contamination survey. Note that instruments prescribed by the RSO may allow simultaneous alpha/beta surveys (e.g., Ludlum 2360 dual-channel scaler with Ludlum 43-93 alpha/beta probe). Contact the RSO if questions regarding instrument selection and/or use arise when performing contamination surveys required.

<u>General Considerations for Equipment Release Surveys:</u>

- If equipment has been washed prior to surveying, make sure equipment is dry. Alpha particles will not penetrate a layer of water on the equipment.

- Using Form SOP-06A *Equipment Release Survey Form*, document:
  - Location where the equipment was used,
  - Description of the equipment,
  - Name of the individual conducting the release survey,
  - Release survey date, and
  - Specific components of the equipment and/or location(s) surveyed. A photo diagram on the second page of the form, with annotated location ID numbers corresponding to the locations listed on page 1, is suggested but not mandatory.
- In addition, document the information regarding each radiological survey instrument used including:
  - Serial number,
  - Calibration date,
  - Instrument background measurement (at the survey location), and
  - Total detection efficiency (ε_t), as determined under SOP-03.

<u>Total (Fixed + Removable) Surface Contamination Survey:</u>

- Scan for total alpha activity (and total beta activity, if appropriate) on accessible surfaces of potentially contaminated items by placing the detector approximately 0.5 cm from the surface and moving the detector over the surface at about 2 cm per second.
- If elevated counts are detected in an area while scanning (relative to background levels), take a static 1-minute scaler count where highest elevated counts were observed. If no elevated counts observed while scanning, then select location(s) based on potential likelihood for contamination and make a 1-minute scaler count at each location.
- The number of measurement locations must be sufficient to adequately represent the entire item being surveyed. For each measurement, record the location and resulting scaler count rate (in CPM) on Form SOP-06A *Equipment Release Survey Form*.
- For each static measurement location, convert the net survey count rate (in cpm) to units of total surface activity (DPM/100 cm^2) using Equation 3-1. Record the result

on Form SOP-6A *Equipment Release Survey Form* in the column labeled Total Alpha Activity (and Total Beta Activity, if appropriate).

Removable Surface Contamination Survey:

- If the total (which includes fixed & removable fractions) surface activity for alpha radiation (as measured in the above step) is less than the removable limit (1,000 dpm/100 cm^2) across all scanned surfaces, a swipe test for removable alpha contamination is technically unnecessary. Note that this consideration does not apply to removable swipe testing of packages used to ship samples containing radioactive materials under UN2910 excepted package protocols (i.e., swipe testing is always required for shipment of radioactive materials).
- If the total measured surface activity exceeds the removable limit anywhere on the equipment being surveyed, swipe testing shall be performed in areas with the highest scan readings, along with several other locations as needed to provide representative coverage of accessible surfaces. At each location, swipe test an area of 100 cm^2 (approximately 4 x 4 inches) and subsequently count the sample to determine the alpha activity that is removable. Note that for UN2910 shipping container surveys, the area to be swipe tested is 300 cm^2.
- Ideally, swipe samples are counted with an instrument that has an attached or built-in sample counting tray (e.g., Ludlum Model 2929 scaler with Model 43-10-1 detector or a combined Model 3030 sample counting instrument), but a portable alpha/beta survey detector may also be used, provided the meter includes appropriate dual channel scaler counting capability (e.g., Ludlum Model 2360 scaler with 43-93 alpha/beta detector). In the latter case, a simple makeshift counting jig can be used to provide a consistent measurement geometry for sample counting, instrument efficiency determinations, and daily function checks. Such a counting jig, where the plastic detector cover is used to maintain a consistent distance of about 0.5 cm between the detector and the sample or check source, is shown in Figure 3-1.
- Once the swipe sample has been counted, convert the net count rate (in cpm) to units of removable gross alpha surface activity (DPM/100 cm^2) using Equation 3-1.
- Record the result in the column labeled Removable Alpha Activity on Form SOP-06A *Equipment Release Survey Form*.

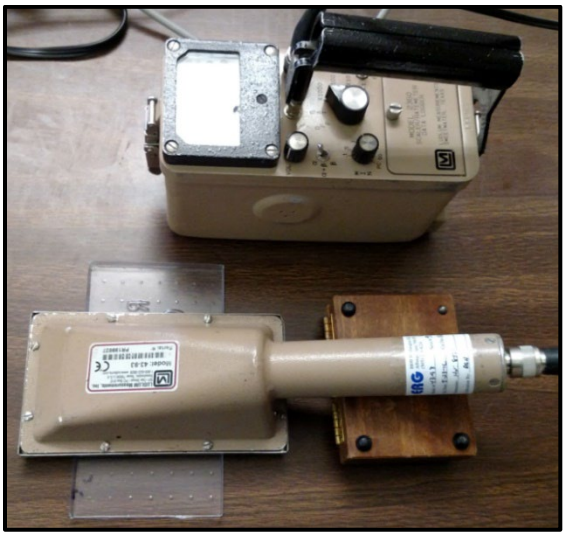


Figure 3-1: Example fixed-geometry measurement jig using a Ludlum 43-93 survey probe to count swipe samples, determine instrument efficiency, and to perform daily QC function checks.

Swipe Testing for UN2910 Shipping Packages:

The procedure for swipe testing UN2910 shipping packages is the same as indicated above for equipment release surveys except for the following:

- The areal basis for swipe testing is 300 cm^2.
- A swipe removal efficiency value of 0.1 must also be applied, in addition to the applicable total efficiency (ε_t) value given in SOP-03.
- Applicable limits differ.
- Results of the surveys should be recorded on Form SOP-10A *UN2910 Shipping Package Survey Form*.

See SOP-10 for more details regarding UN2910 shipping of radioactive materials.

3.4 Personnel Exit Surveys

Personnel working in a restricted area are required to scan their clothing, exposed skin, and shoes upon leaving the area. All workers will be instructed in the use of the survey instruments and performing a proper personal exit survey and documenting results on the Form SOP-06 *Personnel Exit Survey Form.* Basic steps for personnel exit surveys are as follows:

- While holding an alpha detector approximately 0.5 cm from the surface to be scanned, survey at a rate of approximately 2 inches per second, paying attention to the audible output (clicks) and/or analog dial response or digital display readings.
- If audibly or visually elevated counts (relative to background) are observed while scanning, pause at that location to confirm whether the counts are at background levels or consistently above.
- If count rate is at background levels, continue with the survey.
- If count rate exceeds the background level, carefully scan around the location to determine the extent of the elevated readings. Note the area for subsequent decontamination and continue scanning until the survey is completed.
- If above-background contamination is identified, the decontamination procedures in Section 4 of this SOP will be followed as applicable.
- If radioactivity above background persists after decontamination, and the applicable regulatory limits in Table 3-1 cannot be met with standard decontamination procedures, consult the RSO for further advising.

An administrative release limit will be determined each day by the RST for each survey instrument to be used based on the maximum ambient "background" count rate observed at the personnel exit survey location. This release limit will be labeled at the top of the Form SOP-06B *Personnel Exit Survey Form* provided for the day. Personnel must acknowledge and document that they have performed a personnel exit survey by providing the date, name, company, any special notes regarding the survey, and to confirm that the release limit was met by initialing the Personnel Exit Survey Form in the indicated column.

3.5 Documentation and Records Retention

The RSO and RST will record/document results of all instrument QC measurements and survey or monitoring results and will maintain all documentation indefinitely until disposition is authorized by NRC. The RSO, ARSO, and RST will retain all completed Survey Forms (Forms SOP-06A, SOP-06B, and SOP-10A) and associated QC data (from SOP-02 and SOP-03) and will maintain these records along with all documentation as indicated above.

4. DECONTAMINTION

4.1 Overview

The surfaces of equipment, vehicles, personal protective equipment (PPE), clothing or skin could potentially become contaminated in excess of administrative action levels or regulatory release limits. In such cases, decontamination is required before releasing the person and/or equipment from the Site. This procedure describes the methods for decontamination.

4.2 Decontamination Facilities and Equipment

Once a decontamination area is selected, the same location should be used for this purpose until project completion and associated procedures are no longer required. A source of clean water and common tools for washing or other means of removing contaminated residues from the surfaces of equipment or personnel will be provided as needed to attain compliance with applicable release limits. The following is a list of decontamination equipment and materials:

- Personal protective equipment, including Level D work clothing, Tyvek coveralls, rubber boots, nitrile gloves, face shields, etc. as required.
- Decontamination equipment and materials, as required (e.g., clean water supply, biodegradable detergent, pressure washer, brushes, double-sided sticky tape, etc.).
- Container(s) for waste materials generated due to decontamination activities, as required.

4.3 Decontamination Methods

- Use of scrapers or brushes can be effective for removing gross accumulations of dirt or mud on equipment, vehicles, and PPE. Stiff-bristled brushes or other abrasive removal methods should not be used for skin to avoid damaging the skin and creating a potential pathway for absorption of contamination into the bloodstream.
- Decontamination with water (e.g., washing skin, pressure washing dirt/mud from equipment, etc.) is effective for most contamination likely to be present. Mild, biodegradable soap or detergent can increase the effectiveness of water as a decontamination agent.
- Disposable wet-wipes or double-sided sticky tape can be effective for removing small amounts of removable contamination or short-lived radon decay products from skin or clothing.

4.4 Personnel Decontamination

If radioactive surface contamination exceeding the administrative limit (above background) is identified on skin, clothing or PPE for personnel working in a Restricted Area, the affected area(s) must be decontaminated. Brushing off visible accumulations of dirt or mud may be sufficient for clothing or PPE, but skin should be gently washed with mild soap and water.

In cases where simple decontamination efforts to remove long-lived radiological contamination (as opposed to short-lived radon decay products) prove ineffective, the RSO or RST must be notified for further advising. The RST will assist the contaminated personnel until the decontamination process has been completed or otherwise terminated. The following are general considerations to be observed during personnel decontamination activities:

- Administration of first aid for immediate treatment of serious injuries or illness must take priority over personnel decontamination considerations.
- Decontamination of serious wounds (other than minor cuts or abrasions) shall be performed by professional medical personnel.
- Minor wounds (cuts, abrasions, etc.) can be flushed with lukewarm water or a saline solution.
- Use protective clothing (i.e., gloves, etc.) as necessary when decontaminating personnel to prevent inadvertent secondary spread of contamination.
- The mildest methods of decontamination should be attempted first, progressing to harsher methods when necessary. Cleansing methods, from the least harsh to the most are listed below:
    - Flushing with water
    - Soap and warm water
    - Mildly abrasive soap, soft brush, and water

4.5 Decontamination of Personal Clothing or Articles

- Decontamination of clothing or personal articles may be performed by the individual under the direction of the RST and in accordance with this procedure.
- Personal clothing or items may be released when surveys indicate that surface activity meets the administrative limit provided at the top of the Form SOP-06B *Personnel Exit Survey Form*.

Special Note: Short-lived airborne decay products of radon gas (progeny) can readily adhere to clothing via static charge, particularly fleece and polyester materials. Radon progeny may produce false positive readings on personnel exit surveys. Radon progeny on surfaces are NOT considered contamination or a health concern as within several hours, the associated radioactivity will decay away. Washing skin and use of double-sided sticky tape rollers (lint removal devices) on clothing can help to remove radon progeny and reduce false positive survey readings for long-lived radionuclides, which are the primary concern. If these measures do not reduce survey readings to acceptable levels, the individual may resurvey after 15-30 minutes. If readings have measurably decreased, this is an indication of radon progeny not long-lived contamination, and the person may leave the Site without need for further decontamination. Alternatively, the article(s) of clothing may be placed in a plastic bag, left onsite, and be resurveyed the following morning to verify that short-lived radon progeny has decayed, and readings have returned to background levels.

4.6 Decontamination of Equipment and Vehicles

- Gross accumulations of dirt or mud on equipment and vehicles shall be removed with a flat bladed scraper, brushes or by pressure washing within the decontamination area.
- Personnel performing decontamination shall wear appropriate PPE as needed (e.g., when using a pressure washer).
- Equipment such as drill rigs, auger, drill bits, and shovels should be sprayed with water (high pressure, if required) to remove potentially contaminated accumulations of mud or dirt. Care should be taken to adequately clean hard to reach places on complicated pieces of machinery.
- After cleaning and sufficient drying of equipment has been completed, perform appropriate radiological surveys, as indicated in this SOP, to ensure that the equipment meets applicable criteria for release for unrestricted use as specified in Table 3-1.
- Perform additional decontamination as necessary until applicable limits are met.

5. REFERENCES

5.1 Radiation Protection Program (RPP) Manual

5.2 U.S. Nuclear Regulatory Commission (NRC) Regulatory Guide 8.30

6. ATTACHMENTS

6.1 Form SOP-06A Equipment Release Survey

6.2 Form SOP-06B Personnel Exit Survey

6.3 Form SOP-10A UN2910 Shipping Package Survey

Form SOP-06A **Equipment Release Survey Form**

Site:		**Equipment Use/Location:**		Page	
Survey Description:		**RWP #**		**DATE:**	

Meter / Detector (radiation survey type):	**Detector Area (cm^2)**	**Serial Number:**		**Cal. Due Date:**		**Background (CPM)**		**Total Efficiency (counts/decay)**	
		Meter	**Detector**	**Meter**	**Detector**	**Alpha (α)**	**Beta (β)**	**Alpha (α) ****	**Beta (β) ****
Model 2360 / 43-93 (α/β)	100								
Model 19 (γ)	NA		NA		NA		(μR/hr)	NA	NA
Model 2929 Swipe Counter (α/β)	32								

Contamination Limits: (dpm/100cm^2) *		Removable α: **1,000 (200)** dpm/100 cm^2			Removable β: **1,000 (200)** dpm/100 cm^2			Total α: **5,000** dpm/100 cm^2			Total β: **5,000** dpm/100 cm^2			Net γ: **25** μR/hr	
Sample No.	Description/ Location	Gross CPM α Removable	Net CPM α Removable	dpm/100cm^2 α Removable	Gross CPM β Removable	Net CPM β Removable	dpm/100cm^2 β Removable	Gross CPM α Total	Net CPM α Total	dpm/100cm^2 α Total	Gross CPM β Total	Net CPM β Total	dpm/100cm^2 β Total	**Gross Gamma (μR/hr)**	**Net Gamma (μR/hr)**
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															

REMARKS:	
TECHNICIAN SIGNATURE/DATE:	
REVIEWER SIGNATURE/DATE:	

***Administrative limit given in parentheses**

****Per SOP-03**

DISA

Form SOP-06B **Personnel Exit Survey Form**

Date _____ Restricted Area Location _____

Instrument Serial Numbers: Detector_____ Meter_____

Maximum background alpha surface activity prior to first daily entry into Restricted Area _____cpm [1]

ACTION LEVEL = max background_____ (cpm) × 1.5 = _____cpm [2]

(*NOTE*: if background is ≤ 2 cpm, a value of 4 cpm should be used as the release limit)

Initialing this Exit Survey Form indicates that you have performed and passed the Personnel Exit Survey.

Name (please print)	Company	Survey Result below Action Level (Yes or no)	Initials

[1] The RST will determine the maximum background alpha count rate on his/her clothing/skin first thing in the morning each day, prior to entry of any personnel into the Exclusion Zone.

[2] To account for temporal variability in background levels of short-lived radon progeny on clothing/skin, the daily background alpha activity value is multiplied by a factor of 1.5 to determine the daily personal exit survey limit.

Disa Technologies, Inc.

SOP-07 Rev. 0

Emergency Response

Standard Operating Procedure

Approvals

_____ _____

Chief Operating Officer *Date*

_____ _____

Radiation Safety Officer *Date*

REVISION LOG		
Revision Number	**Description of Changes**	**Pages Affected**
0	**Initial Release**	**All**

1. PURPOSE

The purpose of this procedure is to provide instruction on the specific actions to be taken in the event of a radiological emergency at a site or while working with licensed radioactive materials. Emergency actions that fall outside of the scope of the license, or are not explicitly allowed by the license, will be taken only as approved by the RSO. The appropriate regulatory authority will be notified before, or immediately after, emergency actions, using the appropriate reporting procedures specified in 10 CFR Part 40, or as specified in an application document. Occupational safety emergencies will be addressed in a site-specific health and safety plan.

2. RESPONSIBILITIES

2.1 Radiation Safety Officer (RSO), Assistant Radiation Safety Officer (ARSO) –

- Ensuring implementation of this procedure, and that the emergencies and incidents are reported as specified in 10 CFR Part 40.

2.2 Radiation Safety Technician (RST) –

- Implementation of this procedure in response to site radiological incidents and emergencies.

3. PROCEDURE

The following procedure identifies the immediate, supplementary, and any follow-up actions for high airborne radioactivity and for spills of radioactive solids or liquids, fires, and loss of radioactive material (RAM) and related notification to appropriate parties. Personnel will conform to reporting and notification requirements in accordance with the requirements 10 CFR Part 40.

3.1 High Airborne – High airborne conditions are defined as unexpected particulate radioactivity above 9 E-09 µCi/ml for beta and/or gamma emitter(s) or 2 E-11 µCi/ml for an alpha emitter(s) in occupied radiological areas at the work location.

NOTE: High airborne contamination is not expected in ground moving and excavation tasks. However, cutting, grinding, or burning of material may be performed in containment, thus warranting these precautions.

- <u>IMMEDIATE ACTIONS:</u>

- Evacuate personnel from affected areas.
- Notify RSO, ARSO, or RST.
- Don respiratory equipment for personnel who must return to the affected area.
- Secure air moving equipment (e.g., fans, window air conditioners, and unit heaters) in the affected spaces to help prevent further spread and releases.
- Verify that the high airborne results (e.g., from air sampling or elevated instrument readings) are correct.
- Determine the extent of the airborne radioactivity by sampling air in the affected area and adjacent areas which might be affected using portable air samplers.

- SUPPLEMENTARY ACTIONS:
  - Attempt to identify the radionuclide causing the airborne radioactivity using process knowledge and/or by promptly measuring the sample to determine activity characteristics (alpha vs beta vs gamma) and the half-life.
  - Measure and control surface contamination in areas affected by high airborne radioactivity.
  - When resuming operations, take a portable air sample to verify that the cause of high airborne radioactivity is corrected.
  - Check personnel exposed to high particulate radioactivity for internal radioactivity (swipes of inside of respirators, contamination on face, etc. followed by appropriate bioassay sampling if found contaminated).
  - A report of any incident involving high airborne radioactivity other than natural background in areas occupied by personnel not wearing or wearing inappropriate respiratory equipment, will be prepared. The report will include results of internal monitoring and will be submitted to the RSO within ten working days.

3.2 Radioactive Spills

The following steps will be followed in the event of a radioactive spill of liquids or solids. Ensure that proper personal protective equipment (PPE) is donned prior to addressing any spills. PPE could include chemical resistant gloves, protective coveralls, and chemical resistant boots.

- IMMEDIATE ACTIONS:

- If the spill is minor (e.g., a few liters of water with low radioactivity spilled on a smooth surface), immediately cover the spill with the most convenient absorbent paper or rags to soak up the liquid. Experience has indicated in most cases that for minor spills involving small amounts of radioactivity, wiping up the spill even though gloves are not available, will not result in additional contamination of the individual.
- After the spill is covered, follow portions of steps 1 through 5 and supplementary actions below, as necessary, to keep the incident under control. These immediate actions may take place simultaneously.
- The individual at the scene will take charge of the spill until relieved by a radiation safety representative (e.g., RSO, ARSO, or RST). This individual organizes the personnel available and initiates action to control and correct the spill. It is important that this individual make known both his/her presence and the fact that he/his is in charge to all others at the scene. On arrival of the designated individual in charge, the status of correction action taken or in progress will be immediately brought to his attention. The person in charge will designate available personnel to perform the following immediate actions (**SWIMS**):

    1. **Stop the Spill**. If the spill is from a system which might have more material (either airborne particulate radioactivity or fluids) to leak out, promptly stop the leak, if possible. If the spill is from an overturned container, try to set it upright if the contents have not all escaped. Wipe up spilled liquid to prevent it from spreading. The time spent stopping a difficult leak depends upon the radiation levels involved, the possibility of inhaling airborne radioactivity from the spill, and the consequences of not promptly stopping the spill. In some cases, a prompt stoppage is unnecessary.

    2. **Warn Other Personnel**. Immediately warn other personnel in the area who might become contaminated by the spill or who are able to help control it. Notify radiological control personnel.

    3. **Isolate the Spill Area**. Keep unnecessary personnel out of the area affected by the spill to minimize the spread of contamination.

    4. **Minimize Personnel Exposure to Contamination and Radiation**. Personnel in the spill area will remain at the edge of the area until radiological control personnel

advise otherwise. Personnel will keep at the edge of the affected area, taking care to minimize spread of contamination. In some circumstances, stepping outside the room where a spill occurred and closing the access is necessary. Contaminated personnel will be decontaminated without delay.

- SUPPLEMENTARY ACTIONS:
    - Measure Radioactivity Levels. Measure contamination on personnel who could have been affected, make contamination surveys in the area adjacent to the spill outside the area isolated, determine the magnitude and extent of surface contamination in the spill area, and measure airborne radioactivity near the spill area. If it is suspected that radionuclides have been taken into the body or if skin contamination is detected, internal monitoring (bioassay sampling appropriate for the radionuclides of concern) may be performed.
    - Take subsequent radiological control and cleanup actions per radiological control personnel instructions.
    - Do not resume operations without the RSO or ARSO approval.

3.3 Loss of Radioactive Material

If licensed radioactive material is lost, the following procedures will be followed.

- The RSO will be immediately notified, and a search conducted. The primary reason for this is to ascertain that no persons will receive inadvertent internal or external exposure from the material.
- If the material cannot be located, the RSO, ARSO, or RST will prepare an incident report in compliance with 10 CFR Part 40.
    - The most likely scenario is loss of a licensed Th-230 check source. A telephone call to NRC will be required within 30 days stating the loss of licensed material and a written report will be submitted within 30 days after the telephone notification.
    - Loss of dispersible source material will require immediate notification to NRC.

3.4 Fire in Controlled Area

- Areas will be evacuated by all non-emergency personnel when a fire, heavy smoke, or similar fumes occur in a controlled area. Radiological controls, operational and/or fire response personnel will be immediately notified.

- When possible, the fire will be extinguished by personnel, using a fire extinguisher or water (whichever is appropriate) in the immediate vicinity (if safe) rather than allowing it to grow larger while designated personnel are on their way.
- If a fire cannot be rapidly extinguished using a fire extinguisher or water, await help from emergency personnel (i.e., firefighters) and evacuate the area as necessary. Inform emergency personnel about the radioactive nature of the material.
- Fire extinguishing agents, such as CO_2, foam, chemicals, are preferred, as this minimizes the volume of potentially contaminated liquids.
- All firefighting personnel will be surveyed prior to exiting the event area, except those in need of immediate medical assistance outside the controlled area. Minimization of the spread of contamination will always be kept in mind.

3.5 Emergency Notification

- In the event of a radiological emergency, notification of the event can be made by calling the RSO or ARSO at phone numbers provided prior to start of onsite work.
- In addition, an emergency call list will be posted in the office area. This call list will provide the name and phone numbers of radiation safety staff, regulatory authority representatives, and fire/first-aid emergency response personnel.
- The chain of contact will proceed as follows, after a radiological emergency:
    - Immediate help from the RSO, ARSO, or RST and field services manager if onsite.
    - Immediate help from fire/first-aid emergency response personnel, if deemed necessary.
    - Call to RSO and field services manager if offsite.
    - Notification to the client of the emergency.
    - Notification to regulators, if required, and as specified for a given emergency.
    - Notification and reporting of emergencies/incidents will be carried out in accordance with the requirements of 10 CFR Part 40.

4. REFERENCES

4.1 Radiation Protection Program (RPP) Manual

Disa Technologies, Inc.

SOP-08 Rev. 0

Air Sampling

Standard Operating Procedure

Approvals

_____ _____

Chief Operating Officer *Date*

_____ _____

Radiation Safety Officer *Date*

REVISION LOG		
Revision Number	**Description of Changes**	**Pages Affected**
0	**Initial Release**	**All**

1. PURPOSE

The purpose of this procedure is to discuss the requirements in the performance of general area air sampling and personnel breathing zone air monitoring while working with licensed radioactive materials that are under the authority of the NMED RCB, US NRC or Agreement State regulatory authority.

2. RESPONSIBILITIES

2.1 Radiation Safety Officer (RSO), Assistant Radiation Safety Officer (ARSO) –

- Ensuring that air sampling provides representative samples of the work area and personnel breathing air, potential intakes (inhalation) of radioactive materials by workers, and/or airborne releases to the environment. Representative sampling allows for the identification and evaluation of potential radiological hazards which may then be controlled.
- Authorizing the sampling methods and the instrumentation to be used for analysis of samples.

2.2 Radiation Safety Technician (RST) –

- Informing the RSO or AU when airborne radioactivity levels have increased unexpectedly.
- Collection of air samples in accordance with this procedure, and preparation and analysis of samples to be counted on-site.
- Ensuring air samplers and counting instrumentation have been properly tested prior to use.
- Submittal of environmental samples to off-site laboratories, as needed.

3. PROCEDURE

3.1 Equipment –

- Air sampling pump(s) appropriate to the sampling effort needs.
  - *Low-volume (Low-vol) and High-volume (High-vol) Air Sampler* – This type of air sampler is typically used for area and perimeter air sampling and have flow rates much higher than breathing zone air samplers. These samplers are most often used when it is necessary to obtain large volumes of air. Flow rates range from 10-100 L/min or greater, depending on model and project needs.

- *Breathing Zone Air Sampler* – This type of air sampler is often called by other names, such as "BZ" (short for breathing zone), "personal air sampler", or "lapel air sampler". A breathing zone air sampler typically has a flow rate of 0 to 5 liters per minute (LPM) but may range higher.

- Appropriate air sampling filter media (size and material).
- Sample counting instrumentation; typically, a tray counter. *NOTE: Tray counter should be properly calibrated, and function checked prior to use.*
- Materials/Forms for documenting air sampling activities and results (See SOP-12 Swipe and Air Sample Counting).

3.2 General Area Air Sampling – General area air samples are taken to determine airborne concentrations where workers may be present. Select sampling locations that are in the general air flow path and representative of conditions where workers are performing their jobs as follows:

- Collect the sample using low-vol or high-vol air sampler.
- Position the sampler head with filter approximately 4 to 6 feet above the floor or ground and orient sampler head horizontally or downwards and 90-degrees to any significant air flow direction, as practical.
- Load the filter media, start the sample pump, and record the location, start date/time, beginning flow rate, and totalizer value, as appropriate for air sampler.

  NOTE: The sampler flow rate and sample collection duration should allow for a minimum quantity of air sampled for general area and breathing zone samples should allow the Lower Limit of Detection (LLD) to be less than approximately 10% of the DAC, as applicable.

- At the completion of the sample collection stop the sample pump, record the stop date/time, ending flow rate, and totalizer value, as appropriate for air sampler.
- Remove the filter media and place in the appropriate container/envelope. *NOTE: Use caution not to cross-contaminate the filter(s).*
- Analyze the air sample in accordance with appropriate site or project counting procedures.

3.3 **Breathing Zone Air Sampling** – The breathing zone of a worker is taken to mean the air that is representative of the worker's inhaled air, that is, the area around the nose and mouth. Breathing zone air samples may be collected using a low-vol or high-vol air sampler, or a BZ or lapel air sampler provided they are representative of the breathing zone and sufficient air volume collection is feasible. Breathing zone air samples are taken for the purpose of estimating personnel exposures to airborne activity associated with specific tasks.

- Attach the sample head to the worker's collar or chest area with the filter head facing horizontally. Instruct the worker to use care not to touch the filter during work. Secure the pump in a manner that does not interfere with the worker's movement.
- Start the pump within a few minutes prior to worker entering the area and record the start date/time, beginning flow rate, and totalizer/run time, as appropriate for the air sampler.
- Stop the pump within a few minutes of the worker exiting the area and record the end date/time, flow rate, and totalizer/run time, as appropriate for the air sampler.
- Remove the sample filter from the filter cassette, and place filter in the appropriate container/envelope.

  NOTE: Use caution not to cross-contaminate the filter.

- Analyze the air sample in accordance with appropriate site or project counting procedures.

4. REFERENCES

4.1 Radiation Protection Program (RPP) Manual

4.2 U.S. NRC Regulatory Guide 8.25, "Air Sampling in the Workplace"

4.3 U.S. NRC Regulatory Guide 4.14, "Radiological Effluent and Environmental Monitoring at Uranium Mills"

Disa Technologies, Inc.

SOP-09 Rev. 0

External Dosimetry

Standard Operating Procedure

Approvals

_____ _____

Chief Operating Officer *Date*

_____ _____

Radiation Safety Officer *Date*

REVISION LOG		
Revision Number	**Description of Changes**	**Pages Affected**
0	**Initial Release**	**All**

1. PURPOSE

The purpose of this procedure is to provide instruction for the routine issuing and use of radiation dosimetry devices (dosimeter), establishing and maintaining associated dose records, routine primary dosimetry exchange, and termination of dosimetry while working with licensed radioactive materials that are under the authority of the US NRC or Agreement State regulatory authority. Additionally, this procedure defines regulatory and administrative exposure limits applicable to workers in accordance with the Radiation Protection Plan.

2. RESPONSIBILITIES

2.1 Radiation Safety Officer (RSO), Assistant Radiation Safety Officer (ARSO) –

- Oversight of the Radiation Protection Program with respect to ensuring compliance to dose limits.
- Ensuring appropriate use of dosimetry.
- Providing the methodology for performing dose calculations including calculation of a "missed dose" when a dosimeter is lost or damaged.
- Review and approval of radiation exposure and dose data.
- Investigating if regulatory and/or administrative limits are exceeded, including documentation of such results.
- Required notifications and reports to workers and regulatory agencies.
- Maintaining dosimetry records.
- Ensuring that workers are restricted from activities that could result in additional exposure when administrative limits are exceeded.

2.2 Radiation Safety Technician (RST) –

- Issue and change out of dosimeter.
- Reporting and replacing lost dosimeter.
- Maintaining an appropriate inventory of dosimeters from the vendor.

2.3 Authorized Users (AUs) –

- Responsible for notifying the RSO when their physician has prescribed radionuclides for treatment or diagnostic purposes.
- Responsible for wearing assigned dosimeter in proper locations as required.

- Responsible for storing assigned dosimeter in designated storage areas when not in use.
- Responsible for reporting lost, damaged dosimetry, or unusual dosimetry readings (based on typical reading for self-reading dosimeter) to the RSO, ARSO, or AU.
- *DECLARED PREGNANT WORKER* – Voluntarily declare pregnancy and the estimated date of conception to the RSO in writing IF they desire to be considered a "Declared Pregnant Worker" for the purpose of application of radiation protection related limits and/or work restrictions.

3. PROCEDURE

3.1 Equipment –

- Dosimeter(s) – typically Optically Stimulated Luminescence (OSL) badge, Electronic Personal Dosimeter (EPD), or similar.

  NOTE: The RSO, ARSO, or AU will make arrangements through an approved and accredited dosimeter service (e.g., by NVLAP) to establish a standing order of dosimeters assigned by name to all full-time project employees including extra unassigned dosimeters for new employees (until added to dosimetry roster) and visitors, etc.

- Disa Dosimetry Form

3.2 General Requirements for External Dosimetry Issuance – Requirements for personnel dosimetry will be determined on a project specific basis. At a minimum, any individual who may receive a dose greater that 10% of the 10 CFR Part 20 limits shall be subject to personal dosimetry.

- The personal dosimetry badge shall be capable of measuring the Deep Dose Equivalent (DDE) at a tissue depth of one centimeter, Lens Dose Equivalent (LDE) at a tissue depth of 0.3 centimeter, and Shallow Dose Equivalent (SDE) at a tissue depth of 0.007 centimeter.
- The purpose of the dosimeter is to determine the accumulated dose of the individual over a period of time for official dose records. Typically, the badges will be processed on quarterly intervals. Dosimeters may be exchanged more often at the discretion of the RSO.
- The dosimeter should be placed on the location of the body expected to be representative of whole-body exposure, typically on the upper torso.

3.3 Initial Badge Issue –

- Ensure that the individual has received radiation safety training and instructions.
- If not already done so by the vendor, label the dosimeter with the individual's name or identification number.
- Record dosimeter number and issuance date on a dosimeter issue form or spreadsheet for record linking specific dosimeters and individual.
- Instruct individual on how/where on body to wear dosimeter (typically the torso) and where to store dosimeter when not wearing it (low background area).

3.4 Dosimeter Exchange –

- Collect all previously issued dosimeters and inventory them against the report of current dosimeter assignments and prepare a list of missing dosimeters. Attempt to recover any missing dosimeters by contacting users.
- Issue new dosimeter to all returning users. If not already done so by the vendor, label the dosimeter with the individual's name or identification number, and record dosimeter number and issuance date on a dosimeter issue form or spreadsheet for record linking specific dosimeters and individual. *NOTE: If dosimeter is damaged remove from service and issue and another dosimeter.*
- Return exchanged dosimeters to vendor for analysis with the upcoming quarter (just received) Transit Control dosimeter and the previous quarter Deployment Control dosimeter with the exchanged dosimeters.

  NOTE: Return Transit Controls immediately and keep Deployment Controls for the full quarter.

- Employee Termination – The RSO should be informed of an employee or contractor termination from the project so that the dosimeter may be collected. Record the termination date on the dosimeter issue form or spreadsheet.

  NOTE: The termination date is the actual last date the occupational radiation exposure monitoring is needed; typically, the last day on site.

3.5 Employee Dose Results – When a dosimeter is returned to the vendor an exposure report for each badge will be made available to the RSO. This record of results shall be maintained for the duration of the license and updated at least annually.

- *Privacy* – Records will be protected from public disclosure due to personal privacy concerns and laws.
- *Lost Dosimeter* – In the event that a dosimeter is lost after it has been used, the dose received shall be estimated by the RSO. Acceptable methods of estimating the dose include using exposures from dosimeters worn by coworkers performing similar duties in the same work areas, and by multiplying average exposure rates for work areas by the time the worker was in these areas.
- *Pregnant Worker* – Exposure records of dose to an embryo/fetus with the records of dose to the declared pregnant woman shall be maintained. The declaration of pregnancy shall also be kept on file but may be maintained separately from the dose records.
- *Reporting* – An individual's exposure may be made available to that individual upon request. If an individual's total occupational dose exceeds 100 millirem (1 millisievert) TEDE or to any individual organ or tissue, then a report will be provided without request.

  NOTE: This report must be furnished within 30 days from the time the request is made or within 30 days after the exposure of the individual has been determined, whichever is later.

4. REFERENCES

4.1 Radiation Protection Program (RPP) Manual

4.2 U.S. NRC Regulatory Guide 8.25, "Air Sampling in the Workplace"

4.3 U.S. NRC Regulatory Guide 4.14, "Radiological Effluent and Environmental Monitoring at Uranium Mills"

5. ATTACHMENTS

5.1 Blank Disa Dosimetry Form

OCCUPATIONAL EXPOSURE RECORD FOR A MONITORING PERIOD

Page ____ of _____

1. NAME (LAST, FIRST, MIDDLE INITIAL)	2. IDENTIFICATION NUMBER	3. ID TYPE	4. SEX ☐ MALE ☐ FEMALE	5. DATE OF BIRTH

6. MONITORING PERIOD	7. LICENSEE OR REGISTRANT NAME	8. LICENSE OR REGISTRATION NUMBER(S)	9A. ☐ RECORD ☐ ESTIMATE	9B. ☐ ROUTINE ☐ PSE

INTAKES

10A. RADIONUCLIDE	10B. CLASS	10C. MODE	10D. INTAKE IN ☐Bq or ☐µCi (Check one)

DOSES IN ☐ Sv or ☐ Rem (Check one)

DEEP DOSE EQUIVALENT (DDE)	11.
EYE DOSE EQUIVALENT (LDE)	12.
SHALLOW DOSE EQUIVALENT, WHOLE BODY (SDE,WB)	13.
SHALLOW DOSE EQUIVALENT, MAX EXTREMITY (SDE,ME)	14.
COMMITTED EFFECTIVE DOSE EQUIVALENT (CEDE)	15.
COMMITTED DOSE EQUIVALENT, MAXIMALLY EXPOSED ORGAN (CDE)	16.
(BLOCKS 11 + 15) (TEDE)	17.
MAX ORGAN BLOCKS 11 + 16) (TODE)	18.
19. COMMENTS	

20. SIGNATURE – LICENSEE OR REGISTRANT	21. DATE PREPARED

1. Type or print the full name of the monitored individual in the order of last name (include "Jr.," "Sr.," "III," etc), first name, middle initial (if applicable)

1. Enter the individual's identification number, including punctuation. This number should be the 9-digit social security number if at all possible. If the individual has no social security number, enter the number from another official identification such as a passport or work permit.

2. Enter the code for the type of identification used as shown below:

CODE	ID TYPE
SSN	U.S. Social Security Number
PPN	Passport Number
CSI	Canadian Social Insurance Number
WPN	Work Permit Number
IND	INDEX Identification Number
OTH	Other

3. Check the box that denotes the sex of the individual being monitored.

4. Enter the date of birth of the individual being monitored in the format MM/DD/YY.

5. Enter the monitoring period for which this report is filed. The format should be MM/DD/YY. – MM/DD/YY.

6. Enter the name of the licensee or registrant.

7. Enter the Department license or registration number or numbers.

9A. Place an "x" in Record or Estimate. Choose "Record" if the dose data listed represent a final determination of the dose received to the best of the licensee's or registrant's knowledge. Choose "Estimate" only if the listed dose data are preliminary and will be superseded by a final determination resulting in a subsequent report. An example of such an instance would be dose data based on self-reading dosimeter results and the licensee intends to assign the record dose on the basis of TLD results that are not yet available.

9B. Place an "x" in either Routine or PSE. Choose "Routine" if the data represent the results of monitoring for routine exposures. Choose "PSE" if the listed dose data represents the results of monitoring of planned special exposures received during the monitoring Period. If more than one PSE was received in a single year, the licensee or registrant should sum them and report the total of all PSEs

FOR ITEMS 10D-18 INDICATE IF THE UNITS ARE SI OR SPECIAL. (SEE RH 4.40.3)

10A. Enter the symbol for each radionuclide that resulted in an internal exposure recorded for the individual, using the format "Xx-##x," for instance, Cs-137 or Tc-99m.

10B. Enter the lung clearance class as listed in Appendix B to Part D (D, W, Y, V, or O for other) for all intakes by inhalation.

10C. Enter the mode of intake. For inhalation, enter "H." For absorption through the skin, enter "B." For oral ingestion, enter "G." For injection, enter "J."

10D. Enter the intake of each radionuclide in Bq or μCi.

11. Enter the deep dose equivalent (DDE) to the whole body.

12. Enter the eye dose equivalent (LDE) recorded for the lens of the eye.

13. Enter the shallow dose equivalent recorded for the skin of the whole body (SDE,WB).

14. Enter the shallow dose equivalent recorded for the skin of the extremity receiving the maximum dose (SDE,ME).

15. Enter the committed effective dose equivalent (CEDE) or "NR" for "Not Required" or "NC" for "Not Calculated".

16. Enter the committed dose equivalent (CDE) recorded for the maximally exposed organ or "NR" for "Not Required" or "NC" for "Not Calculated".

17. Enter the total effective dose equivalent (TEDE). The TEDE is the sum of items 11 and 15.

18. Enter the total organ dose equivalent (TODE) for the maximally exposed organ. The TODE is the sum of items 11 and 16.

19. Signature of the person designated to represent the licensee or registrant.

20. Enter the date this form was prepared.

21. COMMENTS.
In the space provided, enter additional information that might be needed to determine compliance with limits. An example might be to enter the note that the SDE,ME was the result of exposure from a discrete hot particle. Another possibility would be to indicate that an overexposed report has been sent to the Department in reference to the exposure report.

Disa Technologies, Inc.

SOP-10 Rev. 0

Shipping UN2910 Radioactive Material

Standard Operating Procedure

Approvals

_____ _____
Chief Operating Officer *Date*

_____ _____
Radiation Safety Officer *Date*

REVISION LOG		
Revision Number	**Description of Changes**	**Pages Affected**
0	**Initial Release**	**All**

1. PURPOSE

The purpose of this procedure is to provide standard instruction on how to ship a container of soil samples having unknown radionuclide concentrations or activities as UN2910, Radioactive Materials, Excepted Package – Limited Quantity of Material.

NOTE: HAZMAT Shipper Training must be completed every two years. Only personnel trained on HAZMAT shipping may perform UN2910 shipping procedures.

2. DISCUSSION

This procedure is to ensure proper packaging, labeling and shipment of samples when offered as UN2910 Radioactive Materials, Excepted Package – Limited Quantity of Material.

49 CFR 173.403 defines *"Limited quantity of Class 7 (radioactive) material"* as a quantity of Class 7 (radioactive) material not exceeding the material's package limits specified in Section 173.425 and conforming with requirements specified in Section 173.421.

Section 173.425 Table 4 Activity Limits for Limited Quantities shows the limited quantity package limits for *Solids: Normal form* are 1×10^{-3} the A^2 values found in Section 173.435 Table of A^1 and A^2 values for radionuclides. The radionuclides in soil most often shipped by ERG personnel are natural uranium (U-nat) and progeny, and natural thorium (Th-nat) and progeny. The A^2 values for both radionuclides are unlimited and include contributions from progeny with half-lives less than 10 days. The U-nat and Th-nat progeny (with associated A^2 values in curies [Ci]) that must be included in a sum of fractions calculation, for confirmation that limited quantity package activity limits are not exceeded, are shown in below Table 1. The sum of fraction values for both U-nat and Th-nat, assuming a 40-pound consignment, parent radionuclide concentrations in soil of 1,000 pCi/g, and progeny in secular equilibrium are located in Equation 1 and Equation 2 below. The sum of fraction calculated result in values of less than 1.0 for both U-nat and Th-nat. Therefore, assuming a sample container with no more than 40 pounds of soil containing either U-nat or Th-nat in concentrations of 1,000 pCi/g or less, the container would fall below the activity limits required allowing it to be shipped as UN2910 Radioactive Materials, Excepted Package – Limited Quantity of Material.

Symbol of radionuclide	A^2 (Ci)	Limited Quantity Package Limit (Ci)
U (nat)	Unlimited	Unlimited
Th-230	2.7×10^{-2}	2.7×10^{-5}
Ra-226	8.1×10^{-2}	8.1×10^{-5}
Pb-210	1.4	1.4×10^{-3}
Po-210	5.4×10^{-1}	5.4×10^{-4}
Th (nat)	Unlimited	Unlimited
Ra-228	5.4×10^{-1}	5.4×10^{-4}
Th-228	2.7×10^{-2}	2.7×10^{-5}

Table 1. Table of A^2 Values and Limited Quantity Package Limits

NOTE: A 40-pound container (18,144 grams) of soil samples with U-238 or Th-232 in soil at a concentration of 1000 pCi/g equates to an activity of 1.815 ×10^{-5} Ci of U-238/Th-232. Progeny of U-238 in secular equilibrium would have an activity of approximately 50% of this (a conservatively safe assumption), or 0.907 × 10^{-5} Ci.

$$SOF_{U-nat} = \frac{1.815\ E-5}{Unlimited} + \frac{0.907\ E-5}{2.7\ E-5} + \frac{0.907\ E-5}{8.1\ E-5} + \frac{0.907\ E-5}{1.4\ E-3} + \frac{0.907\ E-5}{5.4\ E-4} = 0.45 \quad \text{(Equation 1)}$$

$$SOF_{Th-nat} = \frac{1.815\ E-5}{Unlimited} + \frac{1.815\ E-5}{5.4\ E-4} + \frac{1.815\ E-5}{2.7\ E-5} = 0.68 \quad \text{(Equation 2)}$$

The Section 173.421 requirements for excepted package for limited quantities of Class 7 (radioactive materials) are such that a Class 7 (radioactive) material with an activity per package which does not exceed the limited quantity package limits specified in Table 4 in Section 173.425 (discussed in previous bullet), and its packaging are excepted from requirements in this subchapter for marking (except for UN identification number), and if not a hazardous substance or hazardous waste, shipping papers, and the requirements of this subpart if:

- Shipped in an appropriate container.
- The radiation level at any point on the external surface of the package does not exceed 0.5 mrem/h (500 µR/h).
- The removable contamination on the external surface of the package does not exceed limits specified in Section 173.443 (a); which are 240 dpm/cm² for beta, gamma and low-toxicity alpha emitters, or 24 dpm/cm² for all other alpha emitters, from a 300-cm²

area; with removable activity calculated using a wipe efficiency of 0.10.

NOTE: Low toxicity alpha emitters means natural uranium; depleted uranium; natural thorium; uranium-235 or uranium-238; thorium-232; thorium-228 and thorium-230 when contained in ores or physical and chemical concentrates; and alpha emitters with a half-life of less than 10 days. If there is any question regarding which alpha contaminant limit to use communicate directly with the Project Health Physicist.

- The outside of the inner packaging or, if there is no inner packaging, the outside of the packaging itself bears the marking "Radioactive".
- The package does not contain fissile material.
- The material is otherwise prepared for shipment as specified in accordance with Section 173.422.

Shipping potentially radioactive samples requires the individual preparing the shipment to have completed Hazardous Materials Transportation – General Awareness/Familiarization, Safety, and Security Awareness Training and the appropriate function specific training for the particular shipping task. The task of shipping potentially radioactive samples requires the 'Function Specific Training – DOT, IATA, & NRC Requirements for Shipping Limited Quantity Radioactive Materials'.

NOTE: Personnel who have not completed the required training or are no longer current on their training are not permitted to ship UN2910 under any circumstances. Under the provisions of Title 49, U.S. Code 5123 (a)(1), persons (as defined in Title 49 CFR 171.8) in violation of the HMR are subject to a civil penalty of up to $50,000 for each violation, and in some instance's criminal penalties.

3. PROCEDURE

3.1 **Supplies -**

- **Shipping Container** – Ship samples in a container that is durable enough to reasonably assume when loaded it will arrive at its destination intact. Select a container of appropriate size to minimize unnecessary void space, and fill remaining void space, as necessary to minimize sample bag movement and resulting leakage. If the container has a drain plug it must be secured in closed position. Shipping containers may be requested from/provided by the analytical laboratory to be used for sample analysis.

- **Sample Bags and/or Sample Containers** – Sample bags or sample containers should not leak or break during shipment. Ziploc type bags can be used for soils and other dry materials, as long as the bag is sealed tight. Consider double-bagging samples to minimize potential spillage. Avoid glass containers, if possible, as they have a higher potential to break during shipment.
- **Laboratory Chain-of-Custody Form** – A completed chain-of-custody (COC) form should always accompany samples sent to a laboratory. *NOTE: Each lab has its own COC form. Use the appropriate lab-specific COC for the lab being shipped to.* Each shipping container should have its own COC placed on top of the samples prior container closure so that it is readily available upon receipt by the lab.
- **Custody Seal** – When the shipping container is loaded and ready to ship, place a custody seal on the shipping container in such a manner that the container cannot be opened without breaking the seal. Custody seals may be requested from/provided by the analytical laboratory to be used for sample analysis.
- **Tape** – Clear packing or strapping tape that will ensure the shipping container remains closed until delivery and intentional opening.
- **Radiological Survey Instruments** – An exposure rate meter such as a Ludlum Model 19, or similar; and a surface activity detector and meter, such as a Ludlum Model 43-93 with Ludlum Model 2360, or similar.

3.2 **Load Samples into Container** – Place the soil samples into the shipping container and limit each shipping container's total loaded weight to no more than 40 pounds. Use more than one container, when necessary. Load samples in a manner that evenly distributes samples throughout the container and attempt to minimize void space. Fill excess void space with packing materials, as necessary.

3.3 **Close Shipping Container** – Fill out a custody seal with signature and date of person securing closure of the shipping container. Place the custody seal in position on the shipping container which will break when the container is opened. Use packing or strapping tape to secure the shipping container lid in a closed position.

3.4 **Survey Shipping Container and Document –** Survey and document in logbook or Form SOP-06B *UN2910 Shipping Package Survey* that the shipping container meets radiological limits for UN2910 Limited Quantity, Excepted Package, which are:

- **Exposure Rate Limit** –

The maximum allowable exposure rate on any external surface of a "Limited Quantity" package shall not exceed 500 µR/hr.

NOTE: Alternatively, if 500 µR/hr on the outside of the package is exceeded, try using a larger package, or limit the number of samples inside the package.

Use the exposure rate meter to measure the shipping containers external surfaces. Record instrument information (make/model/serial number calibration due date) and the maximum exposure rate measured in a project logbook or on Form SOP-06B *UN2910 Shipping Package Survey*.

- **Removable Contamination Limit** –

The maximum allowable removable contamination limit for **"**all other alpha emitters is 24-dpm/cm² over a 300-cm² area, or 7,200 dpm/300-cm².

NOTE: If total contamination levels measured with a handheld instrument are less than 7,200 dpm/300-cm² (2,400 dpm/100-cm² over a 300-cm² area) then removable contamination levels may also be expected to be less than 7,200 dpm/300-cm², and therefore meet the Removable Contamination Limit.

The maximum allowable removable contamination limit for beta, gamma and low toxicity alpha emitters is 240 dpm/cm² over a 300-cm² area, or 72,000 dpm/300-cm².

NOTE: For calculating removable contamination activity a removal efficiency of 0.10 is acceptable.

Use the surface activity detector and meter to measure the shipping containers external surface total contamination levels. If there is any measurable contamination decontaminate the shipping container or use another shipping container. Record instrument information (make/model/serial numbers calibration due date) and the maximum surface activity rate measured in a project logbook or on Form 06B Shipping Container Survey Log.

NOTE: If using a Model 2360 with Model 43-93 detector to measure total surface activity then a typical alpha efficiency of 10-percent and beta efficiency of 15-percent may be used in the calculation. This would result in using action levels of 240 cpm/100-cm² above background for "all other alpha emitters" and 3,600 cpm/100-cm² above background for

beta-gamma and low toxicity alpha emitters. Contamination levels below these values and the package meets the limits specified in Section 173.443 (a).

3.5 **Labeling** – The outside of the container must be marked with a UN2910 label, and include the language Radioactive Material, Excepted Package – Limited Quantity of Material. An acceptable form of this label is included in this procedure as an attachment. The only marking/labeling requirement for this UN number is having the label placed on top of the box. No Dangerous Goods HAZMAT paperwork is required.

3.6 **Ship the Container** – Ship the container via FedEx or UPS.

NOTE: Indicate on the shipping form or label that Dangerous Goods are included. The FedEx labels and online label have an option under Special Services to identify the shipment as having Dangerous Goods. Indicate that Dangerous Goods are packed as Inaccessible, which is to say they are not required to be accessible.

4. REFERENCES

4.1 49 CFR 172 Subpart I

4.2 49 CFR Section 172 – Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, Training Requirements, And Security Plans

4.3 49 CFR Section 173 – Shippers General Requirements for Shipments And Packagings

5. ATTACHMENTS

5.1 UN 2910 Shipping Label

5.2 Form SOP-10A UN2910 Shipping Package Survey

ATTACHMENTS

UN2910 Label

Form SOP-10A **UN2910 Shipping Package Survey Form**

SITE:		PACKAGE DESCRIPTION:		Page	
SAMPLE TYPE(S):		PACKAGE #		DATE:	

Meter / Detector	Radiation Type	Serial Number:		Cal. Due Date:		Background (CPM)		Total Efficiency (counts/decay)	
		Meter	Detector	Meter	Detector	Alpha (α)	Beta (β)	Alpha (α)	Beta (β)
	(α/β)								
	(γ)		NA		NA		(μR/hr)	NA	NA

Contamination Limits:		Removable α: 24 DPM/cm^2 or 7,200 DPM/300 cm^2			Removable β/γ and α_{LT}**: 240 DPM/cm^2 or 72,000 DPM/300 cm^2			Max Gamma: 500 μR/hr	Package Diagram with Annotated Survey Locations:
Sample No.	Description/ Location	Gross CPM α Removable	Net CPM α Removable	dpm/cm^2 α Removable*	Gross CPM β Removable	Net CPM β Removable	dpm/cm^2 β Removable*	Exposure Rate (μR/hr) on Contact	
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									

REMARKS:	
TECHNICIAN SIGNATURE/DATE:	
REVIEWER SIGNATURE/DATE:	

*** Including addition of a swipe removal efficiency factor of 0.1 (i.e., $\varepsilon_t \times 0.1$; see SOP-03)**

**** α_{LT} = Low toxicity alpha emitters**

Disa Technologies, Inc.

SOP-11 Rev. 0

Transport of Uranium Source Material as LSA-1

Standard Operating Procedure

Approvals

_____ _____

Chief Operating Officer *Date*

_____ _____

Radiation Safety Officer *Date*

REVISION LOG		
Revision Number	**Description of Changes**	**Pages Affected**
0	**Initial Release**	**All**

1. PURPOSE

This Standard Operating Procedure (SOP) describes the steps for conducting radiological dose rate and contamination surveys of haul trucks transporting uranium source material as LSA-1. This SOP covers the steps necessary to ensure a haul truck carrying uranium source material meets the DOT requirements to transport material as LSA-1. Requirements include personnel training, radiological dose rate and removable contamination surveys, vehicle placarding and marking, and making sure all paperwork associated with the shipment is correct and complete.

Anyone associated with the loading/unloading, transport of, and radiological survey of the trailer must have all appropriate hazardous materials (HAZMAT) shipper training; including knowledge of emergency response information, self-protection measures, accident prevention methods and procedures, and modal-specific training requirements for the shipment of LSA-1 materials.

2. RESPONSIBILITIES

2.1 Radiation Safety Officer (RSO), Assistant Radiation Safety Officer (ARSO) –

- Development and approval of SOPs and oversight of procedure implementation.

2.2 Radiation Safety Technician (RST) –

- Onsite management and implementation of this SOP, including daily instrument QC checks, radiological surveys, documentation, etc.

3. PROCEDURE

3.1 Equipment –

- Ludlum Model 19 Micro-R Meter (Model 19), or similar.
- Ludlum Model 2929 with Ludlum Model 43-10-1 Dual-Channel Tray Counter (Model 2929), or similar.
- Radiological check source and materials as needed for instrument function checks and efficiency determinations.
- Removable surface contamination swipe (smear) sampling pads.
- SOP-11A LSA-1 Shipment Survey Form to document survey results.

3.2 Contamination Survey Procedure –

Preliminary Radiological Survey Measurements

Function-check radiological survey instruments in accordance with SOP-02 (*Operational Checkout of Single-Channel Detector with Meter*) and SOP-03 (*Operational Checkout of Dual-Channel Alpha/Beta Detector with Meter*), as applicable.

Shipping Manifest Confirmation

Receive the shipping manifest, as prepared by the haul truck driver. Determine the total amount of radioactivity contained in the source materials shipment (expressed as percent uranium oxide (% U_3O_8)) and provide this information along with the measured Transport Index to the driver to complete the shipping manifest. Both values will be determined by the Radiation Safety Technician (RST) and included on Form SOP-11A following radiological release surveys. Confirm that the manifest is complete and correct.

- Must include the Consignor's address.
- Must include the Consignee's address.
- The words "Exclusive Use Shipment" must be included on the paperwork.
- Must include the DOT proper shipping name and description, including:
    - Shipping Name: Radioactive material, low specific activity (LSA-I)
    - Hazard Class: Class 7
    - Identification Number: UN2912
    - Packaging: Bulk-Unpackaged
    - Quantity: Total amount of radioactivity being shipped in terabecquerels (TBq) and in curies (Ci).

      NOTE: This value is calculated on Form SOP-11A based on the source materials grade and measured net weight of source materials in the shipment.

    - Radionuclide(s): U-Nat, Pb-210, Po-210, Ra-226, Rn-222, Th-230.
    - Form: Solid (Uranium Ore Concentrate)
    - Transport Index: The Transport Index (T.I.) will be calculated below.
- The emergency contact and phone number need to be included.
- The Facility Service Manager must certify the shipment by signing and dating the manifest.
- Keep a copy of the shipping manifest with the contamination survey log form for the shipment.

Visual Vehicle Inspection

Walk around the trailer and visually confirm and document of Form SOP-11A the following:

- The tarp cover assembly and gates must be closed and secured.
- There should be no loose or leaking material observed on the trailer. If loose material is identified, then it should be removed.
- The words "RADIOACTIVE – LSA" and "FOR RADIOACTIVE MATERIALS USE ONLY" are stenciled or marked in a visible and conspicuous place on both sides of the trailer on the in 3-inch letters.
- If the shipping manifest indicates a quantity greater than 0.053 Ci then the letters "RQ" must also be stenciled or marked in a visible and conspicuous place on both sides of the trailer in 3-inch letters.
- Each side and end of the trailer shall have a "RADIOACTIVE" placard.

Radiological Survey Release

Dose Rate Measurements

The Ludlum Model 19 instrument measures external gamma exposure rate [in units of micro-roentgen per hour (µR/hr)]. For the purposes of this procedure, the measured exposure rate value will be considered equivalent to the tissue-equivalent dose rate [in units of microrem per hour (µrem/hr)], and this dose rate will be divided by 1,000 to obtain the dose rate in units of millirem per hour (mrem/hr) as required by DOT regulations.

- Walk around the trailer making periodic measurements with the Ludlum Model 19 on the side, top and underneath surfaces. No point on the external surfaces should exceed 200,000 µR/hr. Enter the measurement results and locations on Form SOP-11A. Use the calculator spreadsheet to assist with calculations.

  NOTE: The maximum reading a Ludlum Model 19 can display is 5,000 µR/hr. If this rate is exceeded, then contact the site Radiation Safety Officer (RSO) for further guidance.

- Walk around the trailer making periodic measurements 2-meters from the trailer side. No point on the external surfaces should exceed 10,000 µR/hr. Confirm on Form SOP-11A that no readings exceed 10,000 µR/hr.

- **Transport Index** – At the location exhibiting the highest gamma rates make a measurement 1-meter from the trailer side. The Transport Index is equivalent to the millirem measurement.

  EXAMPLE: 2 millirem (2,000 µR/hr) at 1-meter away results in a T.I. of 2.0.

  Record on Form SOP-11A the Transport Index. Provide this value to the driver to compete the shipping manifest.
- Make a measurement in the haul truck driver's cab (occupied space) with the Ludlum Model 19. No point in the cab should exceed 2,000 µR/hr. Confirm on Form SOP-11A that no readings exceed 2,000 µR/hr.

Removable Contamination Measurements

Make enough removable contamination measurements to ensure the trailer has been adequately surveyed.

- Select locations on the trailer to make removable contamination measurements. Swipe locations should be selected to identify areas of possible contamination; tires, visible dust, gates, etc.
- Using a removable contamination swipe and pressing downward on the surface, cover an area of 300-cm², approximately 2-inches wide by 24-inches long.
- Count the swipes on the Ludlum Model 2929 with Ludlum Model 43-10-1 tray counter (or equivalent) and enter the results on Form SOP-11A. No removable contamination measurement may exceed 24 dpm/cm² for alpha or 240 dpm/cm² for beta-gamma. The removable activity calculations must account for the 0.10 removable efficiency. This factor is built into Form SOP-11A calculator spreadsheet already.

Survey Documentation

- If using the digital form (calculator spreadsheet), print Form SOP-11A from the Form SOP-11A Calculator spreadsheet. Otherwise, perform and check calculations and fill out Form SOP-11A completely and accurately.
- Review and confirm all criteria result in a "PASS" result, and there are no failures. If results are acceptable, sign and date the form. If results are not acceptable then identify what additional information is necessary and/or contact the site RSO for additional guidance.
- Make a copy of final documentation and provide to the haul truck driver for their records.

- Attach the shipping manifest copy provided by the haul truck driver to the completed Form SOP-11A and file.

4. REFERENCES

4.1 Radiation Protection Program (RPP) Manual

5. ATTACHMENTS

5.1 Form SOP-11A LSA-I Shipment Survey Form

Form SOP-11A LSA-I Shipment Survey Form

Facility: _____ Transport Vehicle ID: _____ Date/Time: _____

Shipping Container Contents Description: _____ U3O8 Grade: _____%

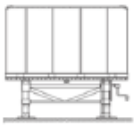
Has a complete and correct Shipping Manifest been provided?		Yes or No	
Is the tarp cover assembly and tailgate fully closed and secured?		Yes or No	
Is there loose or leaking material observed on vehicle?		Yes or No	
Is the vehicle properly marked and placarded?		Yes or No	
Maximum exposure rate 2-meters from vehicle outer lateral surfaces (µR/hr):		Consignment Limit: 10,000 µR/hr	
Maximum exposure rate vehicle cab-interior (µR/hr):		Limit: 2,000 µR/hr	
Transport Index (T.I.)		T.I. Limit: 10.0	

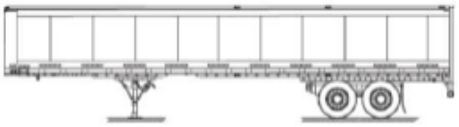
Instrument Make/Model:						
Instrument Serial No.:						
Calibration Due Date:						
Total Efficiency (cpm/dpm): [2]	*Cs-137 Button Source*	*n/a*	*alpha:*		*beta:*	
Background (counts):						
MDA (dpm/100-cm²): [4]		*n/a*				

#	Package/Description	Contact Exposure Rate Limit: 200,000 µR/hr		Remov. Alpha Activity [3] Limit: 24 dpm/cm²		Remov. Beta Activity [3] Limit: 240 dpm/cm²		Meets DOT Limits For Shipping
		Gross (µR/hr)	Net (µR/hr)	Gross Counts	Activity (dpm/100 cm²)	Gross Counts	Activity (dpm/100 cm²)	
1								
2								
3								
4								
5								
6								
7								
8								

Top

Front





Driver Side

Rear

Passenger Side

Bottom

Comments:

Technician Signature/Date:

Reviewer Signature/Date:

Notes:

(1) Radiological check sources used:

ALPHA: Th-230 (s/n:)		2π dpm
BETA: Tc-99 (s/n:)		2π dpm
Remov. SOURCE Count Time:		minute(s)
Remov. BKG Count Time:		minute(s)
Remov. SAMPLE Count Time:		minute(s)

(2) If instrument function check is within acceptable range then total efficiency number used is based on intial instrument QC counts. The instrument total efficiency is calculated per NUREG 1575; Total Efficiency = Instrument Efficiency x Source Efficiency. Alpha source efficiency and beta source efficiency (for < 400 keV) = 0.25.

(3) Smear removal efficiency of 0.10 used in removable activity calculation.

(4) Calculations rely on user set count times.

Page _____ of _____

SOP-3A - LSA-I Shipment Survey Form

Facility: _____ Transport Vehicle ID: _____ Date/Time: _____

Shipping Container Contents Description: _____ U3O8 Grade: _____%

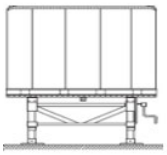
Has a complete and correct Shipping Manifest been provided?		**Yes or No**	
Is the tarp cover assembly and tailgate fully closed and secured?		**Yes or No**	
Is there loose or leaking material observed on vehicle?		**Yes or No**	
Is the vehicle properly marked and placarded?		**Yes or No**	
Maximum exposure rate 2-meters from vehicle outer lateral surfaces (µR/hr):		**Consignment Limit: 10,000 µR/hr**	
Maximum exposure rate vehicle cab-interior (µR/hr):		**Limit: 2,000 µR/hr**	
Transport Index (T.I.)		**T.I. Limit: 10.0**	

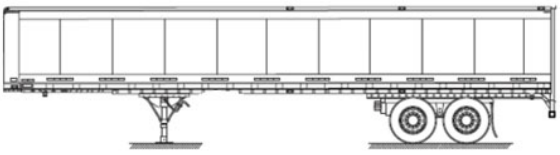
Instrument Make/Model:						
Instrument Serial No.:						
Calibration Due Date:						
Total Efficiency (cpm/dpm): (2)	*Cs-137 Button Source*	*n/a*	*alpha:*		*beta:*	
Background (counts):						
MDA (dpm/100-cm²): (4)		*n/a*				

#	Package/Description	Contact Exposure Rate Limit: 200,000 µR/hr		Removable Alpha Activity (3) Limit: 24 dpm/cm²		Removable Beta Activity (3) Limit: 240 dpm/cm²		Meets DOT Limits For Shipping
		Gross (µR/hr)	Net (µR/hr)	Gross Counts	Activity (dpm/100 cm²)	Gross Counts	Activity (dpm/100 cm²)	
1								
2								
3								
4								
5								
6								
7								
8								

Top

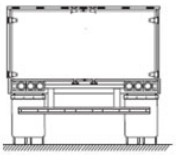
Front

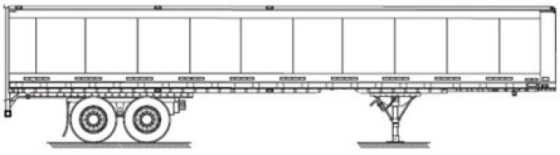




Driver Side

Rear





Passenger Side

Bottom

Comments:

Technician Signature/Date:

Reviewer Signature/Date:

Notes:

(1) Radiological check sources used:

(2) If instrument function check is within acceptable range then total efficiency number used is based on intial instrument QC counts. The instrument total efficiency is calculated per NUREG 1579; Total Efficiency = Instrument Efficiency × Source Efficiency. Alpha source efficiency and beta source efficiency (for < 400 keV) = 0.25.

ALPHA: Th-230 (s/n:)		2π dpm
BETA: Tc-99 (s/n:)		2π dpm
Remov. **SOURCE** Count Time:		minute(s)
Remov. **BKG** Count Time:		minute(s)
Remov. **SAMPLE** Count Time:		minute(s)

(3) Smear removal efficiency of 0.10 used in removable activity calculation.

(4) Calculations rely on user set count times:

Disa Technologies, Inc.

SOP-12 Rev. 0

Removable Contamination Swipe and Air Sampling Filter Analyses

Standard Operating Procedure

Approvals

_____ _____

Chief Operating Officer *Date*

_____ _____

Radiation Safety Officer *Date*

REVISION LOG		
Revision Number	**Description of Changes**	**Pages Affected**
0	**Initial Release**	**All**

1. PURPOSE

The purpose of this procedure is to provide guidance and identify requirements for the counting of removable contamination swipes (smears) and air sample filters (filters) by personnel working under the Disa Radioactive Materials License.

2. RESPONSIBILITIES

2.1 Radiation Safety Officer (RSO), Assistant Radiation Safety Officer –

- The requirements of this procedure are properly implemented.
- All staff, including project employees and contractors at a site, are properly trained to perform activities identified in this procedure.
- Swipe and filter counting records are properly reviewed.

2.2 Radiation Safety Technician (RST) –

- Use calibrated counting instruments.
- Generate and maintain records in accordance with this procedure.
- Perform counting instrument function checks, and notify the RSO, ARSO, or AU when operational checks fall outside acceptable ranges.
- Notify the RSO, ARSO, or AU when sample activity is detected above established limits and/or criteria.

3. PROCEDURE

3.1 Equipment and Materials –

- Calibrated scalar meter with tray-counter detector (tray counter), e.g., Ludlum 2929 with 43-10-1, or equivalent.
- Radioactive check sources, e.g., Th-230 (alpha) and Tc-99 (beta), or equivalent.
- Planchet(s)

3.2 Function Check – The tray counter shall be function checked prior to use in counting swipes or filters using the most current revision of SOP-03 *Operational Checkout of Dual-Channel Alpha/Beta Detector with Meter*.

3.3 Sample Counting – For counting swipes or filters:

- Obtain tray counter background; place a blank swipe or filter on a planchet and count for one-minute, or sufficient time to achieve the necessary counting minimum detectable activity (MDA).

  NOTE: The MDA should be approximately 10% of, but no greater than 50% of, the applicable contamination limit or DAC. The MDA and detector efficiency may be calculated on a results calculator spreadsheet form or noted on the instrument function check form and calculated using the instrument's initial QC counts, per SOP-03.

- Record the background counts onto Form SOP-12A – *Removable Contamination Survey Results Form* for swipes or Form SOP-12B – *Air Sample Filter Results*, or equivalent calculator spreadsheet form, as appropriate.
- **For Swipes –** Place the sample swipe on a planchet and count for the one-minute, or sufficient time to achieve the necessary counting MDA, and record the results on SOP-12A or equivalent calculator spreadsheet.
- **For Air Filters –** Place the sample filter on a planchet and count for the sufficient time to achieve the necessary counting MDA.
  - Enter the air sample start time, end time and flow rate onto Form SOP-12B – *Air Sample Filter Results*, or form calculator spreadsheet to calculate the volume of air sampled.
  - Record the sample counts onto Form SOP-12B – *Air Sample Filter Results*, or form calculator spreadsheet.

    NOTE: Air Sample Filter Results Form calculator spreadsheet will calculate all appropriate DAC values.

- Compare counting results to project or site contamination or air concentration limits. Notify RSO of any failures.

4. REFERENCES

4.1 Radiation Protection Program (RPP) Manual

4.2 SOP-03 Operational Checkout of Dual-Channel Alpha/Beta Detector with Meter

5. ATTACHMENTS

5.1 Form SOP-12A Removable Contamination Survey Results Form

5.2 Form SOP-12B Air Sample Filter Results

Form SOP-12A **Contamination Survey Form**

Site:		**Equipment Use/Location:**		Page	
Survey Description:		**RWP #**		**DATE:**	

Meter / Detector (radiation survey type):	**Detector Area (cm^2)**	**Serial Number:**		**Cal. Due Date:**		**Background (CPM)**		**Total Efficiency (counts/decay)**	
		Meter	**Detector**	**Meter**	**Detector**	**Alpha (α)**	**Beta (β)**	**Alpha (α) ****	**Beta (β) ****
Model 2360 / 43-93 (α/β)	100								
Model 19 (γ)	NA		NA		NA		(μR/hr)	NA	NA
Model 2929 Swipe Counter (α/β)	32								

Contamination Limits: ($dpm/100cm^2$) *		Removable α: **1,000 (200)** $dpm/100\ cm^2$			Removable β: **1,000 (200)** $dpm/100\ cm^2$			Total α: **5,000** $dpm/100\ cm^2$			Total β: **5,000** $dpm/100\ cm^2$			Net γ: **25** μR/hr	
Sample No.	Description/ Location	Gross CPM α Removable	Net CPM α Removable	$dpm/100cm^2$ α Removable	Gross CPM β Removable	Net CPM β Removable	$dpm/100cm^2$ β Removable	Gross CPM α Total	Net CPM α Total	$dpm/100cm^2$ α Total	Gross CPM β Total	Net CPM β Total	$dpm/100cm^2$ β Total	**Gross Gamma (μR/hr)**	**Net Gamma (μR/hr)**
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															

REMARKS:	
TECHNICIAN SIGNATURE/DATE:	
REVIEWER SIGNATURE/DATE:	

***Administrative limit given in parentheses**

****Per SOP-03**

Site:		Survey Locations Diagram	Page	

Insert Photo Diagram or Sketch of Locations Here

Air Sample Collection and Analysis Log

Air Sample Collection:

			Sample Number:			
			Technician:		Date:	
	Air Sampler Make/Model:		Air Sampler Serial Number:		Air Sampler Calibration Due:	
1	Collection Start Time (24:00):		Collection Stop Time (24:00):		Elapsed Time (min.):	
	Flow Rate Start (LPM):		Flow Rate Stop (LPM):		Flow Rate Average (LPM):	
					Volume (ml)	
2	Collection Start Time (24:00):		Collection Stop Time (24:00):		Elapsed Time (min.):	
	Flow Rate Start (LPM):		Flow Rate Stop (LPM):		Flow Rate Average (LPM):	
					Volume (ml)	
	Total Air Sample Volume (ml):					**0.00E+00**

Air Sample Analysis:

	Tray Counter Make/Model:		Tray Counter Serial Number:		Tray Counter Calibration Due:	
	Alpha-Channel Efficiency [1]:		Radionuclide Of Concern:		DAC Limit [2] (µCi/ml):	
1			Analysis Date:		Analysis Time (24:00):	
	Total Alpha Background Counts:		Background Count Duration (min.):		Alpha Background Count Rate (cpm):	
	Gross Alpha Sample Counts:		Sample Count Duration (min.):		Sample Count Rate (cpm):	
	MDA (µCi/ml):		**Gross Alpha Conc. (µCi/ml):**		**Percent of DAC:**	
2			Analysis Date:		Analysis Time (24:00):	
	Total Alpha Background Counts:		Background Count Duration (min.):		Alpha Background Count Rate (cpm):	
	Gross Alpha Sample Counts:		Sample Count Duration (min.):		Sample Count Rate (cpm):	
	MDA (µCi/ml):		**Gross Alpha Conc. (µCi/ml):**		**Percent of DAC:**	

Notes:

1. Alpha Efficiency calculated as (net source counts (cpm)/4-pi source activity (dpm)) × 0.85 (filter self-absorbtion factor).

2. DAC Limits provided in 10 CFR 20, Appendix B, Table 1.

Comments:

Completed By: _____ **Date:** _____

Reviewed By: _____ **Date:** _____

Disa Technologies, Inc.

SOP-13 Rev. 0

Radioactive Materials and Waste Storage

Standard Operating Procedure

Approvals

_____ _____

Chief Operating Officer *Date*

_____ _____

Radiation Safety Officer *Date*

REVISION LOG		
Revision Number	**Description of Changes**	**Pages Affected**
0	**Initial Release**	**All**

1. PURPOSE

The purpose of this procedure is to provide guidance and identify requirements for radioactive materials and waste storage and disposal/recycling at sites and where Disa has responsibility for managing these materials for its projects.

2. RESPONSIBILITIES

2.1 Radiation Safety Officer (RSO), Assistant Radiation Safety Officer (ARSO) –

- Ensuring radioactive materials (source material) are transported to a licensed processing or licensed disposal facility, prior to demobilization from a site.
- Ensuring waste storage does not occur beyond the completion of each individual project and before demobilization.
- Posting of radioactive materials and waste storage areas.
- Ensuring security to radioactive materials and waste storage areas and access by only trained and authorized personnel.
- Ensuring radiation surveys (exposure rate and contamination, as applicable) are conducted in radioactive materials and waste storage areas.
- Ensuring that radioactive materials and waste storage containers are properly labeled.
- Development of procedures for specific waste types, as necessary, beyond the basic descriptions in this SOP.
- Supplying radiation work permits, as necessary, for activities where no developed procedure applies.

2.2 Radiation Safety Technician (RST) –

- Proper posting of radioactive materials and waste storage areas.
- Compliance with posting and procedures.
- Preventing unauthorized access to radioactive materials and waste storage areas.
- Performing routine equipment function checks, and for notifying the RSO, ARSO, or AU when equipment function checks fall outside acceptable ranges.
- Conducting radiation surveys (exposure and contamination, as applicable) of radioactive materials and waste storage areas.
- Labeling, as applicable, radioactive materials and waste storage containers.

2.3 Field Services Manager (FSM) –

- Enforce and comply with recommendations and requirements as specified by the RSO, ARSO, or RST.
- Supply adequate resources to ensure compliance with this procedure.

3. PROCEDURE

3.1 Equipment and Materials –

- Appropriate radiation survey equipment to perform exposure rate (e.g., Ludlum Model 19 or equivalent) and contamination surveys (Ludlum 2360 with 43-93 and Ludlum 2929 with 43-10-1, or equivalents).
- Labels for posting areas and containers.
- Posts and rope/tape to cordon off the restricted area or any other are as deemed necessary by the RSO/ARSO.

3.2 Function Check – Equipment will be function checked prior to use, using appropriate standard operating procedures.

3.3 Packaging and Repackaging of Radioactive Materials or Waste –

- Users shall wear appropriate PPE, as identified by the RSO.
- Dosimetry shall be worn, as determined necessary by RSO.
- Establish a restricted area.
- Material and waste containers shall meet the necessary requirements for transportation or will be repackaged into appropriate containers (e.g., IP-1, IP-2, IP-3, Type A) prior to transport.
- Dry waste shall be packaged separately from liquid waste (no scintillation vials or other liquid waste with dry waste).
- Drums, if used, shall have a plastic liner to receive the waste, if liquids are being stored.
- Liquid waste shall be double contained to prevent leakage.
- Containers shall be sealed when full and sufficient head space allowed for expansion.
- Remove any lead or other shielding prior to conducting radiological monitoring of the container.

- The area and container shall be monitored for contamination and radiation levels (radiation levels shall be taken in low background area, 0.05 mR/hr or less). All surfaces of the container shall be monitored to find the highest radiation level.

3.4 Storage and Segregation of Radioactive Materials and Waste –

- Material and waste shall be stored in authorized locations only.
- Material and waste storage areas shall be appropriately posted using Caution or Danger Radioactive Material language.
- Material and waste storage containers shall be labeled using Caution or Danger Radioactive Material language.
- A physical inventory will be conducted at least every 6 months and documented. The documentation will include radionuclides, radioactivity, location, date of the inventory and person conducting the inventory.
- The material and waste inventory will be kept current.
- Collection containers for material and waste may be kept within restricted areas and will be transferred to storage container(s) when the collection container approaches being full.
- Radiological surveys (exposure rate and contamination surveys) will be taken at least monthly while waste is being handled.
- Segregate radioactive material in storage areas.
- Keep or remove non-radioactive waste out of radioactive material and waste areas.
- Keep mixed Low-Level Radioactive Waste (LLRW) in separate containers from non-mixed LLRW.
- Separate radioactive material and waste from explosives.
- Separate potentially contaminated areas from clean areas by barriers or other controls.
- Ensure waste acceptance criteria (WAC) of potential disposal facilities allow for disposal of specific nuclides. Nuclides that are not allowed shall be packaged separately. This shall be accomplished at the point of generation.
- Higher activity waste (if operations could result in a dose greater than 100 mrem/yr) shall not be segregated or handled without a Radiation Work Permit (RWP) approved by the RSO.

- Material and waste may be consolidated if WAC and container volume allow. Consolidation of material and waste will be conducted by procedure SOP-04 – Guidelines for Handling Radioactive Material or a radioactive work permit (RWP) if dose levels could exceed 100 mrem/yr.

3.5 Transfer or Disposal of Waste –

- Radioactive material for disposal or recycling may be transferred to another licensed recipient who is licensed specifically for the category of material to be disposed.
- All material and waste will be transported offsite prior to demobilization of the High-Pressure Slurry Ablation equipment.

4. REFERENCES

4.1 Radiation Protection Program (RPP) Manual

Disa Technologies, Inc.

SOP-14 Rev. 0

Radiation Safety Training

Standard Operating Procedure

Approvals

_____ _____

Chief Operating Officer *Date*

_____ _____

Radiation Safety Officer *Date*

REVISION LOG		
Revision Number	**Description of Changes**	**Pages Affected**
0	**Initial Release**	**All**

1. PURPOSE

The purpose of this procedure is to outline the radiation safety training requirements for all employees and contractors working under the Disa Radioactive Materials License performing work that is under the jurisdiction of the NRC or Agreement State regulatory authority. This SOP provides guidance in preparing and implementing the radiation safety training (training) program for employees and contractors. The Radiation Safety Officer (RSO) is responsible for review and approval of training materials for all staff designated as an Authorized User (AU), RSO Designee, or Radiation Safety Technician (RST), or for those staff working with radioactive materials or in a restricted area.

Note: An AU may oversee and direct the use of or handling of licensed radioactive material.

Training will be commensurate with assigned duties and responsibilities. All AUs and RSTs will receive additional training on the use of radiation detection instruments and radiation protection monitoring.

2. RESPONSIBILITIES

2.1 Radiation Safety Officer (RSO) or Assistant Radiation Safety Officer (ARSO) –

- Review and approve of all training materials for staff designated as an AU, RST, or for those staff working with radioactive materials or working in or frequenting a restricted area; ensuring training materials are consistent with the requirements of the RPP and this SOP, and that training reflects work methods that are consistent with Disa ALARA policy.
- Work with project or site management to ensure all staff, including contractors at a site working with licensed radioactive materials or working in or frequenting a restricted area, receive prior training commensurate with their duties.
- Provide training, exam, and grading of exam.
- Provide remedial training for deficiencies, as warranted.
- Ensuring refresher training is provided, as warranted.
- Properly maintain training records.

2.2 Radiation Safety Technician (RST) –

- Work with project or site management to ensure all staff, including contractors at a site working with licensed radioactive materials, or working in or frequenting a restricted area, receive prior training commensurate with their duties.
- Properly maintain training records.
- Oversee the use of, or handling of, licensed radioactive material.
- An RST will report directly to the RSO for radiation safety purposes.

2.3 Field Services Manager (FSM) –

- Ensure all employees comply with training and site access requirements.
- Coordinate with the RSO, ARSO, and RST for new employee training prior to working with radioactive materials or working in, or frequenting, a restricted area.
- Work with the RSO or ARSO to ensure all workers receive training commensurate with their duties prior to work in a restricted area.

2.4 Authorized Users (AUs) –

- Attend training and briefings on radiation safety.
- Comply with training and site access requirements; do not work with licensed radioactive materials or in a restricted area without appropriate training and/or access permission.

3. PROCEDURE

Radiation safety training will be designed to inform employees of the inherent risks of exposure to radiation as well as the fundamentals of protection against exposure. The radiation safety training program will be administered following guidance provided in NRC NUREGs 1556 Vol. 11 and 18, NRC Regulatory Guide 8.13, NRC Regulatory Guide 8.29 and other national and industry wide radiation safety training guidance. All employees will be provided access to and made familiar with instructions outlining radiation safety and emergency procedures. Additionally, all workers who enter restricted areas will be provided instructions in accordance with 6 CCR 1007-1 Part 10.

Radiation Safety Training –

Prior to using licensed radioactive materials or working in or frequenting a restricted area, all employees will receive, at minimum, basic radiation training. A qualified instructor will be used for this training. The instructor will have the following qualifications:

- Meets the qualifications for RSO, ARSO, or AU on the license and is familiar with the RPP. Qualifications for these roles are as follows:
  - **RSO** – at a minimum, a bachelor's degree from an accredited program in physical sciences, engineering, industrial hygiene, or health physics and at least 1 year of relevant work experience.
  - **AU** – An AU is a person has been trained consistent with this SOP and commensurate with the hazards and tasks to be performed, who is named either explicitly or implicitly on the license, and who uses or directly supervises the use of licensed materials.
  - **RST** – An RST is an authorized user who has been designated to administer the RPP onsite. The RST will be trained on all SOPs and a practical evaluation will be performed by the RSO to ensure the RST can work independently.
- Should have knowledge and understanding of these principles beyond those obtainable in a course similar to the one given to prospective AUs.
- Should have training and experience that would qualify them to be an AU or should possess a thorough understanding of the site operations.

The radiation safety training may be administered by classroom lecture, video, internet-based class, self-study, or a combination of these and will be commensurate with the expected hazards encountered during routine and emergency conditions. Disa will also provide site-specific training to address the hazards of each individual work site. Additional training will be given whenever a significant change in regulations or the terms and conditions of the service providers license (SPL) occurs.

The radiation safety training will include, at a minimum, the following topics:

- Fundamentals of Radiation Safety:
  - Characteristics of radiation
  - Units of radiation dose and quantity of radioactivity

  - Hazards of exposure to radiation
  - Levels of radiation from licensed material
  - Methods of controlling radiation dose (time, distance, and shielding)
  - As low as is reasonably achievable (ALARA) concept.
- Radiation Detection Instruments:
  - Operation
  - Calibration
  - Limitations of radiation survey instruments
  - Radiation survey techniques for measuring radiation field
  - Radiation survey techniques for measuring removable/fixed contamination.
  - Handling and proper use of personnel monitoring equipment
- Emergency Procedures
- Radiation Protection Equipment and Use:
  - Proper use of protective equipment
  - Decontamination of contaminated equipment
- Applicable NRC regulations (10 CFR Part 10)

A written test with questions directly related to the radiation safety training will be administered to each employee. The instructor will review the test with each employee and discuss any incorrect answers so that the employee understands the error. Workers who do not pass the test with 70% of the answers correct will be retested after receiving additional training. This exam will serve as documentation of completed radiation safety training.

Refresher training is required annually. Employees who do not complete the refresher training within 12 months of the last training will be removed from duties involving licensed radioactive materials until the refresher training is completed. The refresher training will include a brief review of topics covered in the initial training as well as relevant radiation safety issues that have arisen, changes in requirements, and experience (“lessons learned”).

AU and RST Training –

- Authorized Users shall also receive specific training on what license requirement they are going to perform. This may include site-specific training for temporary job sites and/or trainings required under client's licenses.
- RSTs will be assessed by the RSO to ensure that each proposed RST is qualified to work independently and that each individual is knowledgeable of the radiation safety aspects of licensed activities. This may be demonstrated by observing the proposed RST perform licensed activities.

DOT Training for Radioactive Materials – Due to the unique requirement of shipping radioactive Class 7 material, any HAZMAT employee who ships or influences a shipment under the Radioactive Materials License will have DOT training specific to Class 7 material. This training may be given by the RSO, ARSO, or others who have a formal approved training program.

4. REFERENCES

- Radiation Protection Program (RPP) Manual
- USNRC NUREG-1556 Volume 18 Revision 1, Program-Specific Guidance about Service Provider Licenses, 2017
- USNRC, Regulatory Guide 8.13 "Instruction Concerning Prenatal Radiation Exposure" 1999
- USNRC, Regulatory Guide 8.29 "Instruction Concerning Risks from Occupational Radiation Exposure" 1996

Disa, Inc.

SOP-15, Rev. 0

Radioactive Material Receipt

Standard Operating Procedure

Approvals

_____ _____

Chief Operating Officer *Date*

_____ _____

Radiation Safety Officer *Date*

REVISION LOG		
Revision Number	**Description of Changes**	**Pages Affected**
0	**Initial Release**	**All**

1. PURPOSE

The purpose of this procedure is to provide instruction on receiving licensed radioactive materials in excess of Type A quantity (as defined in 6 CCR 1007-1, Section 17.2.2 and Appendix 17A to Part 17) and are under the authority of the US NRC or Agreement State regulatory authority. Packages in excess of Type A quantity should be labeled with Radioactive White II, Yellow II or Yellow III labels or placards, examples of which are provided in Attachments.

NOTE: Typical environmental samples or radiological check sources would not fall under this classification. For shipping environmental samples (soil samples, water samples, etc.) refer to the current version of SOP-10 Shipping UN2910 Radioactive Material.

A radiation and contamination survey must be conducted upon receipt of licensed radioactive materials, with survey records retained for most labeled packages (e.g., special form not required) to comply with NRC regulation 10 CFR Part 20. This procedure establishes specific requirements for conducting receipt surveys, opening of packages, and reporting of unusual observations.

2. RESPONSIBILITIES

2.1 Radiation Safety Officer (RSO) or Assistant Radiation Safety Officer (ARSO) –

- Ensuring implementation of this procedure, including DOT Hazardous Materials Shipper training required of any RST who receives licensed radioactive materials.
- If possible, obtaining shipping information from consignor (party who is shipping) prior to the shipment.
- If possible, reviewing transfer records prior to receipt of radioactive materials to ensure total activity of is within license limits.
- Maintain current licensed radioactive material inventory, and update inventory immediately upon receipt of licensed radioactive material.
- Ensuring for the proper storage, and security for received packages.

2.2 Radiation Safety Technician (RST) –

- Implementation of this procedure when receiving licensed radioactive materials, including notification of the RSO upon receipt of licensed radioactive materials.

- Performing visual inspection, exposure, and removable contamination survey, as appropriate.

2.3 Authorized Users (AU) –

- Notify the RSO or RST upon receipt of radioactive materials.

  NOTE: Common carrier deliveries of radioactive material, not exceeding Type A quantities, are normally received at the client's Shipping/Receiving areas during normal working hours. Immediately upon arrival, receiving personnel shall notify the RSO or RST.

3. PROCEDURE

3.1 Equipment –

- Exposure rate meter; typically, a Ludlum Model 19 or similar.
- Removable surface activity tray counter; typically, a Ludlum Model 2929 scaler and Ludlum Model 43-10-1 dual-channel (alpha/beta) tray counter, or similar.
- Removable surface contamination swipes.
- Materials/Forms for documenting survey activities and results.

NOTE: Radiological survey instruments should be properly calibrated, and function checked prior to use.

3.2 Receiving –

- Review the bill-of-lading and any other documentation provided by the consignor (originator) to verify the radioactivity is within the limits of the license. Verify with the RSO or designee that shipment of Class 7 material from the originator has been authorized.
- A package visual inspection, radiation survey (exposure rate), and removable contamination survey must be conducted on a received package labeled radioactive materials within 3 hours after receipt during normal working hours or within 3 hours after the start of the next working day if received after working hours. NOTE: Unlabeled licensed radioactive material (exempt from DOT regulations or "Limited Quantity, Excepted Package") do not have to meet the 3-hour receipt survey requirements.
  - **VISUAL INSPECTION –** Visually inspect the package for signs of damage or leakage. If damage or leakage is noted, take appropriate precautions to minimize potential

radiation exposure and spread of contamination and notify the RSO if assistance is needed.

- **EXPOSURE SURVEY –** Measure the external radiation level (mrem/hr) at the package surface and at 1 meter from the surface. If radiation levels are greater than 200 mrem/hr at the package surface, or greater than 10 mrem/hr at 1 meter from the package, immediately notify the RSO. In turn, the RSO may need to notify the shipping carrier, the US Department of Transportation, and the appropriate regulatory authority (e.g., NRC Operations Center at 301-816-5100).
- **REMOVABLE CONTAMINATION SURVEY –** Swipe at least 300-cm² of the external surface of the package with moderate pressure and count the swipes for contamination prior to opening the package. Removable contamination on swipes will expressed as dpm/100 cm². NOTE: Use a swipe efficiency of 10-percent in removable activity calculation. If the removable contamination exceeds 240 dpm/cm² beta/gamma and low-toxicity alpha emitters or 24 dpm/cm² for "all other alpha emitters" immediately notify the RSO.

  NOTE: License specific contamination limits may be lower than this.

- Record the receipt survey results on the Radioactive Materials Receipt Survey Form.
- Locate package to a proper and secure storage area.

- **Opening Packages –** Opening and unpacking packages containing licensed radioactive materials will be carried out in an area appropriately controlled and equipped to limit radiation exposure and the spread of contamination.
  - Carefully open the package while being alert for any signs of damage to the inner packing and source container. Monitor radiation exposure levels while opening package. If damage is evident or suspected, swipe the surface of the source container, and request RSO assistance as needed.
  - Remove or deface radiation labels on empty packages. Survey the packing material and the empty package(s) as necessary to assure the absence of contamination. If contaminated, treat as radioactive waste and notify the RSO.
  - Record any elevated survey results or comments on the Shipping Survey Form and provide completed form to the RSO for review and filing.

4. REFERENCES

4.1 ERG Radiation Protection Program (RPP) Manual

4.2 10 CFR 71 – Packaging and Transportation of Radioactive Material.

4.3 40 CFR – Transportation

5. ATTACHMENTS

5.1 Form SOP-15A – Radioactive Materials Receipt Survey Form

Attachments

Type A Packages

Labels are 4” x 4” and are displayed on the outside of packages. The three radioactive labels are show below in increasing hazard (White I, Yellow II, and Yellow III).

Form SOP-15A Radioactive Materials Receipt Survey Form

This statement must be completed by an individual authorized to directly accept shipment of radioactive materials. Record the following information, one form per package.

Order/Shipping Number:	
Vendor:	
Nuclide:	
Activity Received:	
Recipient:	
Exposure Rate, Contact:	
Exposure Rate, 3 feet:	
Wipe Test:	
Receipt Date:	
Receipt Time:	
Person Receiving:	
Signature:	

Exposure is measured with an exposure rate survey meter (e.g. Ludlum Model 19) in a low background area. Record the highest exposure at the package surface and at 3 feet.

Swipe at least 300-cm² of the external surface of the package with moderate pressure. If the removable contamination exceeds 240 dpm/cm² beta/gamma and low-toxicity alpha emitters or 24 dpm/cm² for “all other alpha emitters” immediately notify the RSO.

DISA

Form SOP-15A Radioactive Materials Receipt Survey Form

This statement must be completed by an individual authorized to directly accept shipment of radioactive materials. Record the following information, one form per package.

Order/Shipping Number:	
Vendor:	
Nuclide:	
Activity Received:	
Recipient:	
Exposure Rate, Contact:	
Exposure Rate, 3 feet:	
Wipe Test:	
Receipt Date:	
Receipt Time:	
Person Receiving:	
Signature:	

Exposure is measured with an exposure rate survey meter (e.g. Ludlum Model 19) in a low background area. Record the highest exposure at the package surface and at 3 feet.

Swipe at least 300-cm² of the external surface of the package with moderate pressure. If the removable contamination exceeds 240 dpm/cm² beta/gamma and low-toxicity alpha emitters or 24 dpm/cm² for “all other alpha emitters” immediately notify the RSO.

Disa Technologies, Inc.

SOP-16 Rev. 0

High-Pressure Slurry Ablation Mobilization and Demobilization Standard Operating Procedure

Approvals

_____ _____

Chief Operating Officer *Date*

_____ _____

Radiation Safety Officer *Date*

REVISION LOG		
Revision Number	**Description of Changes**	**Pages Affected**
0	**Initial Release**	**All**

1. PURPOSE

The purpose of this procedure is to define the manner in which the High-Pressure Slurry Ablation (HPSA) equipment will be mobilized, utilized, and then demobilized from a site. This procedure will discuss pre-mobilization activities, establishment of the restricted area and scanning stations, and post-operation equipment releases and site release.

2. RESPONSIBILITIES

2.1 Radiation Safety Officer (RSO), Assistant Radiation Safety Officer (ARSO) –

- All appropriate project/site personnel are properly trained on ALARA principles.
- Radiological surveys are performed to provide current information on the radiological environment(s) to which personnel are potentially exposed, as needed.
- Areas that contain licensed material are properly posted.
- Restricted areas are properly established.
- Appropriate personnel protective equipment (PPE), dosimetry and radiological instrumentation, are prescribed, as needed.
- Radiation Work Permits (RWPs) are used for non-routine operations that has the potential to result in a significant radiological dose based on the radionuclide quantity, form, and work to be performed.
- Stop work authority is maintained and encouraged, as necessary, to ensure ALARA.

2.2 Field Services Manager (FSM) –

- Support the RSO, ARSO, AU, and ALARA program.
- Inform the RSO of any changes to site procedures or schedule that could affect radiation protection.
- Ensure personnel, resources, and support equipment necessary to ensure ALARA are available for project personnel by working with RSO and AU.
- Ensure that stop work authority is maintained and encouraged, as necessary, to ensure ALARA.

2.3 Radiation Safety Technician (RST) –

- Report to the RSO on all radiological matters. Where appropriate, report to the onsite management for support on implementation of the ALARA program.

- Perform radiological surveys to provide current information on the radiological environments(s) to which personnel are potentially exposed, as needed.
- Manage onsite personnel protective equipment (PPE), dosimetry, and radiological instrumentation, as needed.
- Ensure proper recordkeeping, instrument calibrations, and maintenance.
- Post areas that contain licensed material.
- Ensure that stop work authority is maintained and encourage as necessary to ensure ALARA.

2.4 Authorized Users (AU) –

- Comply with the Radiation Protection Plan (RPP) and the Standard Operating Procedures (SOP).
- Attend training and briefings on radiation protection and RWPs.
- Comply with all notices, postings, procedures, and instructions from radiation safety staff.
- Properly use and wear all required PPE.
- Follow basic ALARA principles including time, distance, shielding, and contamination control.
- Obey "stop work" and "evacuate" instructions issued by RSO, ARSO, another AU, or FSM.
- Wear and use monitoring devices as required by site procedures and instructions, postings, or the RSO, ARSO, or RST.
- Plan work ahead of performing work. Attempt to minimize exposures, as necessary.
- Leave Radiation Areas or Airborne Radioactivity Areas when not actively working. Use staging or "wait areas", when designated.
- DO NOT eat, drink, or smoke in restricted areas. One-time use water bottles may be used to stay hydrated.
- Perform a personnel scan for contamination when leaving any Restricted Area.
- Report known/potential radiologically unsafe or noncompliance situations to the RSO or ARSO.
- Report prior or concurrent occupational radiation exposures to the RSO.

- Maintain good housekeeping practices to minimize the spread of radiological contamination.
- Exercise stop-work authority and discuss immediately with RSO, ARSO, or RST any circumstance or condition that you believe is contrary the principles of ALARA.

3. PROCEDURE

3.1 Pre-Mobilization

- Prior to mobilizing any equipment to a site, the FSM and RST shall perform a site reconnaissance to determine the site layout. The site layout will include the placement of HPSA equipment, the alignment of the restricted area, and the location of restricted area access/egress points.
- During the site reconnaissance, the RST shall perform a GPS-gamma baseline survey of the restricted area on 5-m transects.
- Data from this baseline survey will be used to calculate a 95% upper confidence limit that will serve as an action level for post-operation scanning.
- The FSM will stake the locations of all the equipment to be used onsite and the alignment of the restricted area.
- The boundary of the restricted area, must be large enough to include the following equipment, at a minimum:
  - Material Hopper
  - All Conveyors
  - Screen and Crusher
  - HPSA Processing Unit
  - HPSA Containment Berm
  - Product Centrifuge
  - Product Centrifuge Hopper
  - Loader
  - Product Roll-off Container or Trailer
  - Process Water Tank
  - Process Water Treatment Unit
- The restricted area boundary will also include a 5-m buffer around all the equipment.

- All equipment positions and surveyed by GPS.

3.2 Site Security

- As part of the Pre-Mobilization phase, the type of security for the site will be determined.
- Options for site security may include the following:
  - Existing site locking gate
  - Installation of a temporary locking gate
  - Off-hours security guard
  - Company personnel will stay onsite in a mobile trailer

3.3 Mobilization

- After collecting the data for the equipment positions and the restricted area, the GPS data will be downloaded, and a site layout map will be created.
- Using this map, HPSA units and support equipment will be mobilized to the site and placed according to the site layout map.
- Once all the equipment is installed, the restricted area boundary will be erected. The restricted area boundary will be a physical boundary constructed of temporary posts and a physical barrier, such as rope or temporary fences.
- A physical access/egress point will be established with a scanning station for personnel to survey themselves or equipment out of the restricted area.
- A log of all personnel entering/exiting the restricted area will be maintained along that will include personnel survey results, date and time of surveys, and any pertinent information regarding the meters used.
- The RSO, ARSO, RST, FSM, and AUs are the only personnel that may enter the restricted area.
- A decontamination pad will be constructed within the restricted area near the boundary.

3.4 Demobilization

- Once operations are finished all processed material and waste will be removed from the equipment.
- Processed material will be added to the trailer or container for transport to a licensed uranium mill or other licensed disposal facility.
- Any waste contaminated with radioactive materials will be containerized and transported offsite to a licensed disposal facility.

- Uncontaminated waste will be containerized and disposed at a sanitary or construction landfill.
- Equipment being removed from the restricted area will be decontaminated and scanned prior to removal.
- After all materials and equipment have been removed from the restricted area, the RST will perform a GPS-gamma survey of the restricted area using the same transects as the baseline survey.
- A t-test will be performed to compare the means of the baseline and the post-operation GPS-gamma surveys.
- If the means are statistically different, then the higher concentration materials will be excavated and disposed at a licensed disposal facility.
- Once the means of the baseline and post-operation GPS-gamma surveys are statistically the same, the site is considered acceptable for free release. All equipment may be demobilized at this point in time.

4. REFERENCES

4.1 Radiation Protection Program (RPP) Manual

Disa Technologies, Inc.

SOP-17 Rev. 0

Performance-Based Licensing Actions

Standard Operating Procedure

Approvals

_____ _____

Chief Operating Officer *Date*

_____ _____

Radiation Safety Officer *Date*

REVISION LOG		
Revision Number	**Description of Changes**	**Pages Affected**
0	**Initial Release**	**All**

1. PURPOSE

1.1 This procedure presents the method to be utilized by Disa Technologies, Inc. (Disa) to evaluate changes, tests, or experiments to its High-Pressure Slurry Ablation (HPSA) process that have not been directly authorized by the U.S. Nuclear Regulatory Commission (NRC) staff in its Materials License. The NRC staff approved Disa's ability to conduct these reviews in License Amendment ___. Specifically, License Condition __ states that certain changes, tests, or experiments may be made after an analysis is performed that addresses the criteria in License Condition __. This License Condition states that the following regarding decision making:

The licensee's determinations concerning (b) and (c) of this condition, shall be made by a Safety and Environmental Review Panel (SERP). The SERP shall consist of a minimum of three individuals. One member of the SERP shall have expertise in management and shall be responsible for financial approval for changes; one member shall have expertise in operations and/or construction and shall have responsibility for implementing any operational changes; and one member shall be the radiation safety officer (RSO) or equivalent, with the responsibility of assuring changes conform to radiation safety and environmental requirements. Additional members may be included in the SERP, as appropriate, to address operational and technical aspects. Temporary members or permanent members, other than the three above-specified individuals, may be consultants.

The licensee shall maintain records of any changes made pursuant to this condition until license termination. These records shall include written safety and environmental evaluations made by the SERP that provide the basis for determining changes comply with (b) of this condition. The licensee shall furnish, in an annual report to the NRC, a description of such changes, tests, or experiments, including a summary of the safety and environmental evaluation of each. In addition, the licensee shall annually submit to the NRC changed pages, which shall include both a change indicator for the area changed, e.g., a bold line vertically drawn in the margin adjacent to the portion actually changed, and a page change identification (date of change or change number or both), to the operations plan and reclamation plan of the approved license application (as updated) to reflect changes made under this condition.

1.2 Disa's implementation involves producing a description of the change, test, or experiment (herein, referred to as a proposed action), and reviewing applicable license conditions and NRC staff decision documents. If the proposed action is directly authorized under the license, Disa documents that decision. If the proposed action is not directly authorized, then Disa addresses the criteria that are presented in License Condition __. After this review, Disa makes a final determination regarding whether or not the proposed action requires a license amendment and documents that decision.

1.3 Officially this review process is known as the "Performance-Based Licensing Action Review", and these reviews are completed by the Safety and Environmental Review Panel (SERP). Decision documents produced by the SERP are called "SERP Reports." These reports are maintained at Disa's Casper, Wyoming, headquarters.

2. APPLICABILITY

2.1 This procedure only applies to proposed actions that directly involve the management of licensed materials or that may have a nexus to radiological health and safety. For example, the following types of proposed actions would be subject to this procedure:

- Proposed action that involves tests with the HPSA process, and
- Modifications to structures, systems, and components (SSCs) that are used to manage source material.

However, any activity involving Disa or its use of HPSA that do not involve the management and control of licensed materials and associated engineering controls with a nexus to radiological health and safety will not be subjected to this procedure. Similarly, potential changes to standard operating procedures (SOPs) that are developed to meet the requirements of license conditions and applicable regulations will not be subject to this procedure since SOPs are not formally approved by NRC staff. Instead, SOPs are routinely inspected for adequacy. Therefore, these activities, along with SOPs, will not be reviewed as part of this procedure.

The term "nexus to radiological health and safety" is a term used in the definition of construction in 10 CFR 40.4. Under this definition, the NRC states that it is not responsible for regulating activities that do not have a nexus to radiological health and safety. By extension, Disa will only review proposed actions involving the SSCs used to manage and control 11e.(2) byproduct material and respective engineering controls that have a nexus to radiological health and safety under this procedure.

3. RESPONSIBIITIES

3.1 Chief Executive Officer

3.1.1 The Chief Executive Officer (CEO) (or the CEO's designee) is responsible for ensuring that the requirements of this procedure are implemented appropriately.

3.1.2 The CEO (or the CEO's designee) will act as the Chair of the SERP and will be responsible for selecting the additional members of the SERP.

3.1.3 The CEO (or the CEO's designee) will detail the scope of all SERP reviews to ensure that sufficient resources are provided to properly analyze issues before the SERP.

3.2 Radiation Safety Officer

3.2.1 The Radiation Safety Officer (RSO) (or designee) must serve as a member of the SERP.

3.2.2 The RSO's (or designee) primary purpose on the SERP is to ensure that a proposed action shall not compromise the public radiological health and safety, and the environment. The RSO (or designee) will also support efforts to ensure that a proposed action complies with NRC regulations.

3.3 Chief Operating Officer

3.3.1 The Chief Operating Officer (COO) (or designee) must serve as a member of the SERP.

3.3.2 The COO's (or designee's) primary purpose on the SERP is to ensure that a proposed action shall not compromise the operations of the HPSA process and of

Disa's overall operations. The COO also ensures that the proposed action is implemented properly.

3.4 Employees/Contractors

3.4.1 Proposed actions are often identified by employees or contractors or through use of a new project checklist.

3.4.2 Therefore, if an employee or contractor identifies such a necessary change, the employee or contractor should discuss this issue with his or her immediate supervisor or the COO (or designee).

3.4.3 Employees or contractors are also responsible for implementing changes per the procedures approved by the SERP and all other safety work rules, established procedures, and Disa's policies. Employees or contractors are further responsible for reporting the success or failure of a proposed action and, most importantly, any adverse or dangerous conditions produced by the proposed action.

4. SAFETY AND ENVIRONMENTAL REVIEW PANEL

4.1 SERP Function

The function of the SERP is to review proposed actions to determine whether a proposed action is directly authorized, if the SERP may approve the proposed action, or if a license amendment is required for approval. The SERP accomplishes this by performing the following:

- Reviewing proposed actions in the facility or process, with respect to the directly authorized operations, as presented in the NRC license, or other relevant documents, approved by the NRC staff.

- Reviewing proposed actions not presented in the NRC license, or other relevant documents, approved by the NRC staff.

4.2 SERP Organization

The SERP shall consist of the following individuals:

- CEO (or designee), who shall have expertise in management and shall be responsible for managerial and financial approval of all proposed actions.

- The RSO (or the RSO's designee), who shall have the responsibility of ensuring that proposed actions conform to radiation safety requirements.

- The COO (or designee), who has expertise in the HPSA operations and construction and shall have the responsibility of ensuring that proposed actions conform are implemented properly with no impact to the safety of Disa's operations.

- Other, at large, members who possess certain expertise that may be required for specific proposed actions. At large members will be appointed by the CEO and may either be Disa employees or outside consultants.

The CEO (or designee) will act as the Chairperson of the SERP. The Chairperson will appoint a SERP Secretary to act as the facilitator and maintain the records of the SERP. Generally, the RSO will fulfill this role.

5. PERFORMANCE-BASED LICENSE REVIEW PROCESS

5.1 Decisions

When a reviewing a proposed action, the SERP must make one of three decisions. These include:

- Proposed action is directly authorized in License _____;
- Proposed action is not directly authorized; however, the SERP may approve the proposed action based on its review; and,
- Proposed action requires a license amendment.

Each of these decisions must be documented in a report produced by the SERP.

5.2 Proposed Action Description

The first step in the performance-based review process is to develop a proposed action description that is to be reviewed by the SERP. Proposed action descriptions may be produced by any employee of Disa or contractor, at the direction of the CEO. These descriptions do not need to be unnecessarily detailed but must provide sufficient information for the SERP to perform its review. Proposed action descriptions should include the following information:

- General summary of the proposed action;
- Need for the proposed action
- Implementation of the proposed action (whichever are applicable):
  - Process of implementation
  - Equipment (including materials, reagents, SDSs, etc.);
  - Health and safety impacts;
  - Expected wastes (i.e., quantities, activities, concentrations) and waste management;
  - Criteria used to determine success or failure;
  - Sampling and analysis;
  - Quality control;
  - Drawings, schematics, or plans, if applicable; and,
  - Method to report results.

Once completed, proposed action descriptions are circulated to the SERP through the CEO for review. The CEO will compile all comments from the SERP and will submit those comments to the author. No further review will occur until all SERP comments are appropriately addressed. (Note: This procedure is still valid even if the author is a SERP member.) Once finalized, these descriptions will become part of the SERP report that documents the SERP decisions.

5.3 Directly Authorized Review

Once the project description is completed, the SERP will conduct a review to determine if the proposed action is directly authorized. This review will include identifying any applicable license conditions in the most recent amendment of License _____. After identifying the appropriate license condition(s), the SERP will review the appropriate decision documents, which could include the following: Safety Evaluation Reports (SERs), Technical Evaluation Reports (TERs), Environmental Assessments (EAs), or Environmental Impact Statements (EISs).

If the SERP determines that the proposed action is directly authorized in the license and decision documents, the SERP may end its review and prepare a SERP Report. This report should include the following information:

- Proposed action description;
- License conditions directly authorizing the proposed action;
- Citations from the decision documents that authorize the proposed action;
- Declarative statement that the proposed action is directly authorized; and,
- Signatures of all SERP members, signature date, and report date.

If the SERP determines that the proposed action is not directly authorized, then the SERP proceeds with the performance-based review.

5.4 Reviews of Actions Not Directly Authorized

Reviews of proposed actions that are not directly authorized are performed to determine whether or not the SERP may approve these proposed actions. To accomplish this review, the SERP meets to discuss the proposed action description and the results of the direct authorization review presented in Section 4.3. The SERP then analyzes the proposed action by comparing the action to the criteria found in the August 12, 2020, license amendment request. A license amendment is required for any proposed action if the proposed action affects any of the following:

i. Results in any appreciable increase in the frequency of occurrence of an accident previously evaluated in support of the current license conditions.
ii. Results in any appreciable increase in the likelihood of occurrence of a malfunction of an SSC important to safety previously evaluated in support of the current license conditions.
iii. Results in any appreciable increase in the consequences of an accident previously evaluated in support of the current license conditions.
iv. Results in any appreciable increase in the consequences of a malfunction of an SSC important to safety previously evaluated in support of the current license conditions.
v. Creates a possibility for an accident of a different type than any previously evaluated in support of the current license conditions.
vi. Creates a possibility for a malfunction of an SSC with a different result than previously evaluated in support of the current license conditions.
vii. Results in a departure from the method of evaluation described in the current license conditions used in establishing the SER, EA, TERs, EIS, or other analysis and evaluations in support of amendments resulting in the current license conditions.

For purposes of this review, SSCs important to safety means any SSC that has been referenced in a staff SER, TER, EA, EIS, or supplements and amendments, thereof.

6. FINANCIAL SURETY

6.1 Once the proposed action has been analyzed, the SERP will review the proposed action to determine if any adjustment to the financial surety arrangement or the approved amount is required. If the proposed action will require an increase to the existing surety amount, the financial surety instrument must be increased accordingly and approved by the NRC staff or other appropriate regulatory agencies. Pursuant to License Condition___, adjustments to the financial surety are made during the regularly scheduled update.

7. CONSULTATION WITH NRC STAFF

7.1 After the SERP conducts the review process for a proposed change, the CEO and the RSO or their designees and other personnel and/or consultants, as appropriate, may set up and complete conference calls or meetings with the NRC Project Manager, deemed appropriate, in order to brief the NRC staff on the proposed change. The objective of the briefings would be to establish consensus on the approach to the proposed change and consensus regarding the SERP findings.

8. DOCUMENTATION OF SERP REVIEW PROCESS

8.1 After the SERP conducts the review process for a proposed action, it will document its findings, recommendations, and conclusions in a written report format. Additional documents, figures, and tables may be attached to the report form at the discretion of the SERP members.

8.2 The date of the SERP decision will be added to the end of the report, and all members of the SERP will sign the final report. In lieu of a signature, a SERP member may state an approval by email if that particular SERP member cannot be present for the actual SERP meeting. All approval emails will be attached to the SERP report.

8.3 For SERPs consisting of more than six members, a simple majority (i.e., greater than fifty percent) is required to approve a SERP report. However, under no circumstances will a SERP report be approved, if either of the CEO (or the CEO's designee), RSO (or the RSO's designee), or COO (or the COO's designee) does not agree with the conclusion. Furthermore, any disagreement shall be documented in an appendix to the SERP report for future reference.

8.4 If the report concludes that the SERP may approve the proposed action without a license amendment, Disa may implement the proposed action. If the report concludes that a license amendment is necessary before implementing the proposed change, the report will document the reasons.

9. RECORDKEEPING

9.1 SERP proceedings are considered documents associated with the NRC-issued Radioactive Materials License and will be maintained until license termination. SERP reports may be inspected by the NRC staff, and SERP reports may become public records. Therefore, no material that is confidential and/or proprietary to Disa should be placed in any SERP report. If such material is included in a SERP report and the NRC staff requests a copy for its records, the CEO (or the CEO's designee) shall include a request for withholding information from the public for any such information pursuant to 10 CFR 2.390.